QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

The SCIENCE COUNSELOR

Volume XI ★ Number 1 ★ March, 1948

DUQUESNE
UNIVERSITY
PRESS

The Science Counselor

"FOR BETTER SCIENCE TEACHING"

A QUARTERLY JOURNAL *of teaching methods and scientific information especially for teachers of science in Catholic schools. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by*

THE DUQUESNE UNIVERSITY PRESS

Subscription Price: $2.00 per year; Canada, $2.25. Single copies of issues in the current year, 60c each.
Business and Editorial Offices at Duquesne University, 901 Vickroy Street, Pittsburgh 19, Pa.

Volume XI March, 1948 No. 1

CONTENTS

IN FUTURE NUMBERS

Among the articles planned for early publication are:

The Atom in Civil Life
Lewis L. Strauss, Member, United States Atomic Energy Commission, New York City

•

Liquid Air—From Advertising to Zeppelin
Hurd W. Safford, Department of Chemistry, University of Pittsburgh, Pittsburgh, Pa.

•

Shore Fauna of the Hawaiian Islands
R. Hiatt, Director, Marine Biological Station, University of Hawaii, Honolulu, T.H.

•

Radiation Protection
Forrest Western, Assistant Director, Health Physics Division, Clinton Laboratories, Oak Ridge, Tenn.

•

Girolamo Saccheri, S.J.—Non-Euclidean Geometer
Robert B. Morrissey, Professor of Physics, Manhattanville College, New York City

•

Conservation Education for Teachers
George J. Free, In charge, Pennsylvania Conservation Education Laboratory for Teachers, Pennsylvania State College, State College, Pa.

Radioisotopes in Biology
Robert Burris, Department of Bacteriology, University of Wisconsin, Madison, Wis.

•

A River in the Sea
Staff, Division of Oceanography, Hydrographic Office, Washington, D. C.

•

Putting Life into Science
Frank B. Lindsay, Assistant Superintendent of Public Instruction, Sacramento, California

•

Light Wave of Mercury 198 as the Ultimate Standard of Length
William F. Meggers, Chief, Spectroscopy Section, National Bureau of Standards, Washington, D. C.

•

The Presentation of the Atomic Concept of Energy to the Second Year College Chemistry Class
George E. F. Brewer, Head, Department of Chemistry, Marygrove College, Detroit, Mich.

•

Gardens are Science Projects
Paul R. Young, Supervisor of School Gardens, Public Schools, Cleveland, Ohio

The Friends of the Land

• By Louis Bromfield
MALABAR FARM, LUCAS, OHIO

"Most economic and political thinkers of our times recognize our agricultural land, our forests, our mines and oil wells, as the real basis of our economic and political power as a nation, and concede that when these are dissipated or used up we shall become a tenth-rate nation." It is imperative, then, that the public be shown the dangers of the situation.

This is an account of the founding and functioning of a society, composed of some of America's most important citizens, which is dedicated to the conservation of our national resources. It was written by a world famous novelist who is becoming almost as well and favorably known for his interest in conservation and for the advanced agricultural methods he employs on the extensive farm where he makes his home, as he is for his best sellers.

One of the most rapidly growing organizations given over to public welfare in the United States is one called The Friends of the Land. It was founded some eight years ago in Washington, D. C., where a small group of men came together to form a society devoted to the education of the vast American public upon the subject of the natural resources and real wealth of the nation and their conservation. [The group included bankers, industrialists, farmers, physicians, writers, and men from government service. Although of small size the group contained specialists who knew almost all aspects of the problem.] Despite the humbleness of its beginnings, the society, known as the Friends of the Land, has made a large and sturdy growth until today its membership is listed as some ten thousand public-spirited citizens of every walk of life, many of them among the best known American educators of our times. The society has, as well, the sturdy support of countless great bankers, insurance companies and industrial organizations which recognize the fact that the wealth, power, health and living standards of the United States are founded upon the proper care of our natural resources, and in particular, the resources of land, forests and water.

The emphasis of The Friends of the Land from the very beginning has been placed upon education as the means by which a democratic nation can, and inevitably must, correct its ills. With this emphasis in view, the society founded a quarterly publication called *The Land,* which has become unquestionably the best magazine in the field of conservation now published anywhere in the world. It is edited by Russell Lord, an experienced editor and journalist and a veteran in the field of conservation. Its list of contributors is remarkable for variety and for knowledge of the elaborately ramified fields of conservation—sports, health, agriculture and horticulture, flood prevention, forestry, international relations, etc.

More remarkable even than the quality of the contributors to the quarterly and the growth of the society itself, is the fact that not one contributor has ever been paid a penny, although many of them receive hundreds and even thousands of dollars for single stories and articles from other nationally known publications. They contribute their knowledge, abilities, and services free in the belief that the preservation and maintenance of our real wealth and natural resources is the most important problem facing our nation today.

A little later an extra service was added in the form of *The Land Letter,* a communication issued monthly, containing supplementary and occasionally technical information regarding conservation in all its forms, and a record of the meetings, forums, and other activities of the organization, both locally and nationally. *The Land Letter* and the home office in Columbus, Ohio, also provide information and a book buying service on all the many fields involved. *The Land Letter* is edited by Dr. Jonathan Forman, internationally known allergist, expert on nutrition, and the editor of the *Ohio State Medical Journal.*

In the beginning the Society launched, in addition to the quarterly magazine, an educational program consisting principally of open forums conducted in cities and towns throughout the nation. It also set up a list of authorities and specialists, available for local meetings, to speak on the widely diverse aspects of the problem. Here again the services were largely voluntary and given largely without expense by men who were authorities in the various fields; in some cases men who were paid hundreds of dollars an engagement on lecture tours spoke for Friends of the Land without charge. Some asked a fee which they turned over to the society itself. Many of the speakers—small salaried, technical men and college professors—gave their services at great sacrifice in time and money.

Within a short time, following the establishing of forums, a popular and pressing demand arose for the formation of local chapters which could carry on the activities of the organization within definite localities. Although such chapters were never contemplated by the founders, the demand was so great and so pressing that by-laws and means of establishing chapters had

(Continued on Page 40)

For a Way of Living

• **By Harold L. Madison, A.M.** *(Brown University)*
DIRECTOR, CONSERVATION WORKSHOP OF RHODE ISLAND, PROVIDENCE, RHODE ISLAND

This story of the pioneering conservation workshop operated in Rhode Island supplements the article by Mr. Bromfield in this number. It outlines a different method of attack on a common problem.

The efficient work and study pattern described here was planned and developed by an inspiring Director and his committee working with an interested and enthusiastic student group.

Attending a session of the Rhode Island Workshop or joining a similar group in another locality this Summer would be a rewarding experience.

●

To be well fed, well clothed and well housed, these are the primary requisites for human existence. This is one great lesson of two world wars. The corollary to it is that we must adopt a new way of living; must recognize that exploitation, greed and ignorance are out, or else,—or else our grandchildren will be cold, hungry, and exposed to we know not what.

The situation is more than serious; it is critical. Peoples of a war-torn world are turning to America for food, clothing, and shelter; for the mere necessities of life. We are shocked into the realization that America is no longer the land of inexhaustible plenty. If our wonderful resources of soil, water, forest, wildlife and minerals are to give mankind a good living in the generations to come, they must henceforth be regarded as capital assets to be managed on an income producing basis for the good of the whole, and not for the get-rich-quick individual or for favored groups, be they economic or political.

It is fundamental in a democratic nation like America that laws and practices for the good of all come from the people. It follows that to act for the immediate, or for the long range future, the people must be correctly informed of the facts, and be given a sound basis on which to formulate a self-preservation program, a way of living that will guarantee perpetual well-being. Such a program means wise use of all natural resources in such a manner as to insure a sustained yield, and managed so that the take shall not exceed the yield.

Obviously, education is the one channel by which this "conservation" way of living can be achieved. Adult education? Yes; especially for in-training and in-service teachers on whom rests the responsibility of teaching concepts that will create right attitudes for a way of living that has for its purpose the future well-being of mankind. The time has come for man to look at his environment; to learn what is known about it, to realize how completely dependent he is on it, and to possess a right attitude toward it. The desired end of conservation teaching therefore has kinship with such attitudes as fair play and respect for property, and other subjects not set down in a course of study but subjects which every true teacher expects to teach.

THE WORKSHOP

Conservation, then, is concerned with human existence and requires that we have accurate and adequate knowledge of our natural resources. The purpose of Rhode Island's Conservation Workshop is first to provide that knowledge, and secondly, to have the student make the conservation concept a tenet of his philosophy of life. We have come to believe that the Workshop is particularly adapted to accomplish these two goals; that it possesses advantages which could not be had were it an intimate part of a large summer school where many subjects are being taught and where students' interests are distributed among three of four subjects. These advantages are:—

1. Location in beautiful Goddard Park (a state park) where students and faculty are housed in a large mansion. There we eat, sleep, work and play.

2. Concentration on one subject, conservation, for two strenuous and satisfying weeks.

3. Opportunity for informal discussion among students, faculty and guest speakers, a situation which does not commonly prevail in summer schools.

4. Acquaintance, friendships. Everyone knows everyone else. Personalities fit quickly into their appropriate niches. Exchange of ideas takes place naturally and informally. In the usual summer school a student may not come to know more than one or two members of his class.

5. First-hand studies in the field; a minimum of lectures, a maximum of direct contacts.

6. Instruction in small groups, assuring individual attention and opportunity for discussion.

7. Credit of two semester hours (80 laboratory clock hours) at Rhode Island College of Education. Low tuition.

For two weeks we live conservation, see it, talk it; yet we do not tire of it. Rather our students find themselves uplifted by what one has called "a revealing experience which has given a new meaning to life." I wish I could say it more adequately.

(Continued on Page 27)

Fifty Years of Progress in Astrophysics

• By Otto Struve, Ph.D. *(University of Chicago)*
ANDREW MacLEISH DISTINGUISHED SERVICE PROFESSOR AT THE YERKES OBSERVATORY, WILLIAMS BAY, WISCONSIN

Although astrophysics, the study of the physical and chemical characteristics of the heavenly bodies, has been recognized as a separate branch of astronomy for only the past half-century, there have been noteworthy achievements in the field.

In this paper a renowned scientist tells of the progress made in recent years. He discusses the chemical composition of stars, and differences in their color, temperature, density and luminosity, the determination of distances of very remote objects, turbulent motions in stellar atmospheres, and other topics of significance.

"It was certainly one of the most important conclusions of all physical science that there exist in the universe no chemical elements that have not been recognized on earth. . . . "

Fifty years ago the science of astrophysics had just been recognized as a separate branch of astronomy, and when George E. Hale of Chicago founded the Yerkes Observatory at Williams Bay, Wisconsin, he decided to devote the new 40-inch refracting telescope primarily to the study of the physical properties of the sun and the stars. The most important problem which confronted him and his associates was to determine, if possible, the chemical constitution of the various celestial bodies.

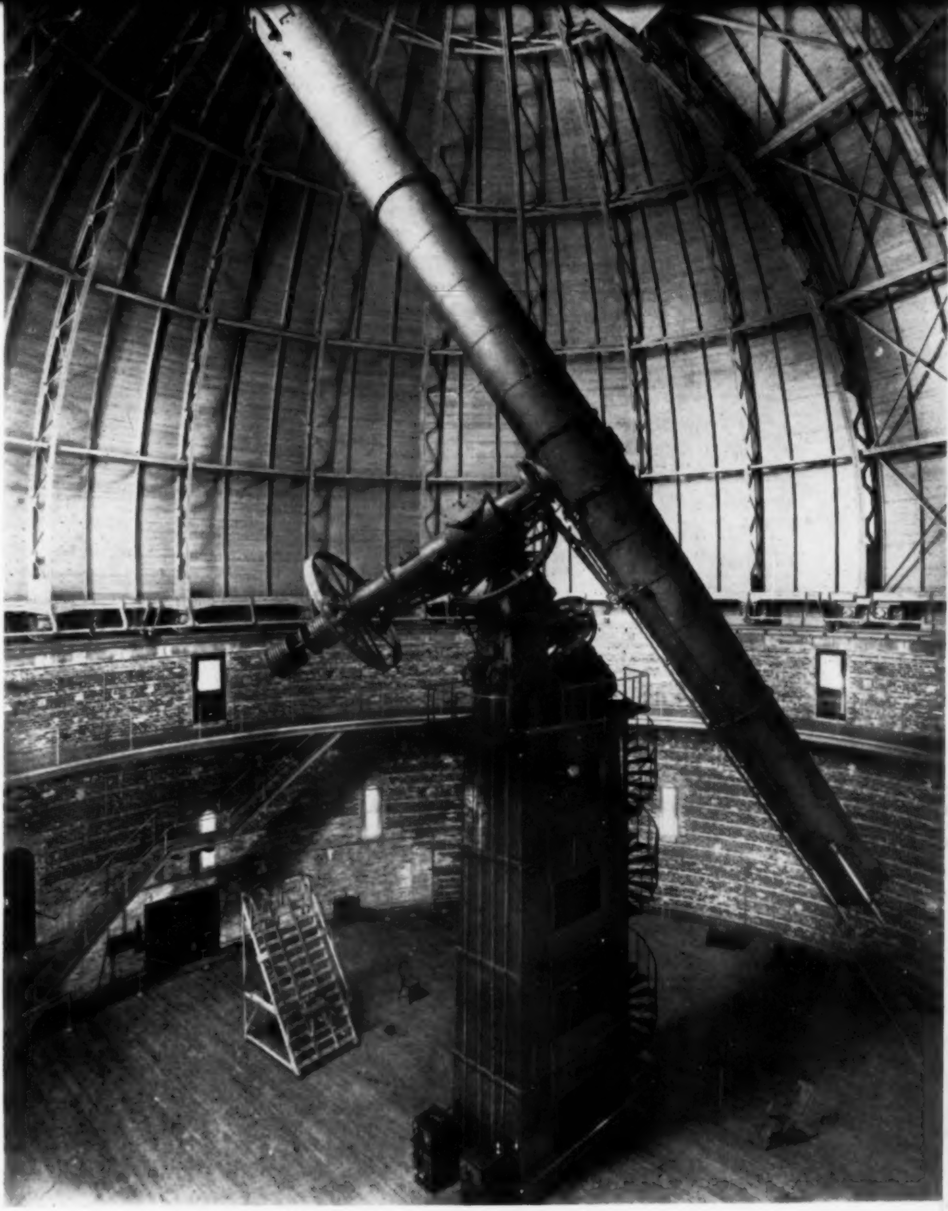
Astronomers already knew from the work of the early spectroscopists that the spectrum of the sun consists of a continuous band of radiation whose intensity distribution resembles that of a black body at a temperature of approximately 6000°; and of a series of narrow absorption lines scattered throughout the continuous spectrum whose origin could be attributed to the vapors of the common elements known on the earth.

THE GREAT OBSCURING CLOUDS in the Constellation Taurus, taken by Barnard with 10-Inch Bruce Lens of Yerkes Observatory.

The work of H. A. Rowland at Johns Hopkins University, which was published in the *Astrophysical Journal* between 1895 and 1897, had led to the identification of thousands of solar absorption lines with the laboratory lines of such common elements as iron, calcium, chromium, manganese, nickel, titanium, hydrogen, etc. It was also known that among the fixed stars there were many whose spectra closely resembled that of the sun, but there were many more that were entirely different. Not only were the continuous spectra of certain stars richer in blue light or in red light than the spectrum of the sun but there were also larger differences in the absorption lines. The blue stars, for example, possessed strong lines of hydrogen and weak lines of helium. Many of them had no lines of the metals, such as iron. On the other hand, the yellow stars had relatively weak lines of hydrogen, no helium, but very strong lines of iron and other metals. The red stars were even known to have absorption bands corresponding to some of the well-known diatomic molecules, such as CH, CN, TiO, and others. It was not surprising that astronomers confronted with these remarkable spectroscopic differences concluded that there were corresponding differences in the chemical compositions of the stars. The blue stars were designated as hydrogen or helium stars. The yellow ones as metallic stars, etc.

There must have been a trace of doubt in the minds of the most active astrophysicists, even as long ago as in 1897. The fact that the apparent chemical composition was so closely related to the color of the star and hence to its temperature must have caused them some concern: could it not be possible that the high temperature of the blue stars somehow tended to suppress the absorption lines of the ordinary metals and hence those of the light gases, and was it not reasonable to suppose that the low temperatures of the red stars might favor the origin of molecules?

It took a long time to find the answers to these questions. The work of Sir Norman Lockyer in England was perhaps the greatest single contribution in this field. He discovered that a chemical element, such as iron, produces different line spectra at different temperatures. When the temperatures are barely sufficient to vaporize the iron terminals of an electric arc, certain lines appear in the spectrum which are characteristic of the element but which can be observed only if the temperature does not exceed a very definite value. Above that critical temperature the so-called "low-level" lines are weak or absent and a new pattern of lines makes its appearance. These "enhanced" lines again give way to a pattern of lines of still greater enhancement which appear at temperatures greatly in excess of those required to produce either the first or the second sets. Lockyer correctly suggested that the spectra of stars of different temperatures should show the different groups of lines and that it should be possible to obtain an estimate of the temperature from the particular pattern of lines of each element observed in a star.



THE 40-INCH REFRACTING TELESCOPE of the Yerkes Observatory.

The final solution of this problem came in 1919 when the Indian physicist Saha announced his famous theory of ionization. As long as an atom of iron possesses its entire retinue of twenty-six electrons, the pattern of spectral lines is that observed at low temperatures in the laboratory or in relatively cool stars like the sun. In the atmospheres of such stars the outermost electron among the twenty-six jumps from one orbit to another and thereby produces the characteristic "low-level" lines. When the temperature rises above a certain value the energy of the collisions between the various particles in the gas causes certain iron atoms to lose their outermost electrons so that only twenty-five are left. It is then the twenty-fifth electron which is essentially responsible for the energy changes within the atom and the corresponding "enhanced" emission of lines. These lines are quite different from those produced by the normal atom. The ionized atoms and the liberated free electrons move about at random so that occasionally a free electron may approach an ionized atom and be captured by the latter. There will be established after a sufficiently long interval of time an equilibrium between the number of processes of ionization and the number of captures. This equilibrium will, of course, depend greatly upon the pressure of the gas. When the pressure is low the distances between the individual particles are great. Processes of collision will occur at relatively infrequent intervals while processes of ionization, depending only upon the intensity of the light from the star, are independent of the pressure. Hence ionization will be favored at low pressures and will be retarded when the pressures are great.

The theory of Saha led to an interesting prediction. Suppose we observe the spectra of two stars whose temperatures, as determined from their continuous spectra, are the same. If the pressures in the atmospheres of the two stars are also the same, then accord-

ing to Saha, the spectra should be identical—provided of course that there are no real differences of chemical composition. If, however, the pressure in one star is greatly in excess of that in the other the normal spectrum of iron should appear in the one of higher pressure and the enhanced spectrum of iron should be observed in the star of lower pressure. This prediction has been amply confirmed by a long series of investigations in which astronomers of many countries have taken an active part. Perhaps the greatest progress was made by W. S. Adams and his associates at the Mount Wilson Observatory. They discovered, even before the theory of Saha had been announced and fully accepted, that it was possible, from the relative intensities of the enhanced and the normal lines, to estimate the intrinsic brightness of the stars. It became at once evident that a very luminous star is one of large volume and consequently low pressure and density, while a star of low luminosity is one of relatively small size and therefore of high pressure and density. The work at Mount Wilson Observatory on the luminosity effects in the spectra of the stars was one of the greatest advancements of science in the early 1920's. It not only gave a complete confirmation of the theory of ionization, but it also provided a tool of great power for the determination of the distances of very remote objects. It was possible to conclude that if two stars have the same apparent brightness—for example, if both appear to the eye as objects of the sixth magnitude—and if from the spectroscopic criteria it was found that one star is 10 000 times more luminous that the other, then their distances must be in the same ratio. Hence, if the distance of the nearer star could be measured by ordinary trigonometric methods, the distance of the other would be derived by multiplying the observed value by a factor of 10,000. It is not an exaggeration to say that almost all our knowledge of the structure of the Milky Way which has developed during the past quarter of a century has come from the Mount Wilson discovery of spectroscopic luminosity criteria.

The theory of ionization dominated astrophysics for a period of ten or fifteen years. Great progress was made in the development of this theory by H. N. Russell at Princeton and E. A. Milne at Oxford. Equally significant advances were made at several observatories, including Mount Wilson, Lick, Harvard, Yerkes and many others. It seemed for a while that the large differences in the spectra of the stars could be entirely accounted for by differences in the pressures and temperatures of their outer layers.

It was certainly one of the most important conclusions of all physical science that there exist in the universe no chemical elements which have not been recognized on the earth and that, in turn, all those elements whose abundances on the earth are large enough, whose spectra are excited under conditions of temperature and pressure similar to those of the stars and whose lines, furthermore, fall within the region of the spectrum which can be observed with astronomical instruments, were actually found in the sun and stars. For a number of years progress in astrophysics depended upon the assumption that the abundances of the elements were strictly the same in all stars and nebulae and that any remaining differences in their spectra must be accounted for by differences in the physical conditions.

During the early 1930's various observations were made which registered appreciable spectroscopic differences among the stars that could not be explained by means of the theory of ionization. It was found, for example, that the relative intensities of the members of a single multiplet of neutral iron could be quite different in different stars. In many simple multiplets the theoretical relative intensities or transition probabilities were already known from the sum rules of Burger and Dorgelo and their various extensions. These relative intensities had been verified by means of laboratory measurements. It was found that they would also apply in the case of absorption lines observed in certain stars. However, in other stars the relative intensities of the multiplet members were proportional to the square roots of the theoretical values, and in still others the range between the strongest and the weakest lines would be even less than would correspond to these square roots. Significantly, no cases were found in which the stellar absorption-line intensities had a greater range than that predicted by the multiplet rules. At first this phenomenon seemed quite obscure. It was not directly related to the temperature because the energy levels within a single multiplet are nearly identical. Hence differences in the degree of excitation could produce only negligible differences in the relative intensities within a multiplet.

Further investigations led to the discovery of an entirely new and unexpected phenomenon. When the observed intensities of the stellar absorption lines are plotted against the theoretical transition probabilities a curve is obtained which has received the name "the curve of growth". This curve has a somewhat complicated appearance. For the smaller transition probabilities the intensities increase, falling upon an approximately straight line whose slope is approximately 45° when the conventional units are used for the coordinates. The strongest absorption lines, which correspond to large transition probabilities, again fall upon a nearly straight line, but its slope is only 22.5°. The intermediate portion of the curve represents the transition from one straight line to the other, and this section is approximately horizontal with a slight amount of curvature at the two ends where it joins the two straight lines. This peculiar looking curve of growth is different for different stars. In some, the intermediate, horizontal section occurs for relatively weak absorption lines, while for other stars it occurs when the absorption lines are fairly strong. It has been shown that this difference is one that depends upon the degree of turbulence or mass motion within the atmospheres of the stars. There are currents of gas, some moving outward, others inward, which can be compared with the thermal turbulence on a sunny day in the atmosphere of the earth.

(Continued on Page 26)

Grandfather Was Not so Dumb!

• **By Richard M. Sutton, Ph.D.** *(California Institute of Technology)*
DEPARTMENT OF PHYSICS, HAVERFORD COLLEGE, HAVERFORD, PENNSYLVANIA

By all means read this delighifully written article. Then reflect a bit.

Nowadays, we use freely the household electrical devices that are so common, with never a thought that they may be far less efficient mechanically than the ones they supplanted, and that in the aggregate they constitute a considerable drain upon our national power supply.

You will be interested in this comparison of a pendulum clock and a modern electric time keeper.

●

A grandfather's clock stands in the hallway of my home where it keeps time faithfully, day after day, year after year. Every Sunday morning I wind it and, in so doing, I break one of the Commandments by doing *50 foot-pounds* of useful work to raise the weights that drive it. I might do the work on Monday, instead, but this simple ritual seems to signify the beginning of a new week. This is almost the only service that the clock requires of me in return for reliable time-keeping and chiming the hour, night and day, for the next seven days. Only half of this work goes into driving the clock: the other half is spent in driving the chime mechanism which tells every hour and half-hour. The clock guards its small supply of energy carefully, spending it at the rate of 300 ergs for every tick-tock, but a thousand times as much for every stroke of the bell. The rhythmic, slow ticking of the escapement measures off the seconds as the pendulum swings sedately. I do not know how many decades it has already run, but it seems never to tire.

Product of the genius of Galileo, Huygens, and generations of skilled clockmakers, this fine old clock seems to partake of the very nature of Eternity, whose tiny segments it carefully defines for my household. Whenever I wind it, I am reminded that Grandfather wasn't so dumb. This instrument of an earlier generation is a rugged but accurate piece of machinery, calling only for a little attention and for a mere pittance of energy to keep it going. Fifty foot-pounds is just about enough energy to raise one ounce of water one-tenth of one degree Fahrenheit!

But Grandfather is hopelessly out of date. Nowadays, everyone measures time by electric clocks, driven by distant and unseen generators. The mighty power plants of our era are kept running so continuously that their very speed of turning has become the symbol and means of accurate time-keeping. Hundreds of thousands of busy little motors are forever spinning out the fabric of time in tiny strands. These motors, geared to the hands of a clock, churn out the seconds quietly and with an agreement that is never achieved by a similar number of clocks individually driven. A new degree of precision in time-keeping has been introduced for the millions. Thanks to electric clocks and the radio broadcast of time at frequent intervals, no one now has any excuse for being more than a minute off from local standard time. Sermons, political speeches, household recipes, and music are now tailored to fit the allotted segments of an ordered day that changes complexion every fifteen minutes. Singing commercials punctuate our days like the semicolons in a long sentence.

Time-telling has become a useful by-product of the generation of electric power. Synchronism of clocks and motors regulates our lives from morning till night, from the changing of radio programs to the operation of traffic lights. The task is performed quietly, sometimes with a faint droning sound, but never with the deliberate or the impatient ticking of a pendulum or the noisy clank of a cheap alarm clock. Appointments are kept more punctually; trains are missed less often.

But Grandfather wasn't so dumb. His clock did for a paltry amount of energy what the modern electric clock does for *18,000 times* as much! If we find a 60-watt light too dim to read by, we put in a 100-watt bulb and think nothing of it. And when we are told that a single electric clock requires only 2 watts to drive it, we dismiss such a trivial power requirement as completely insignificant.

But consider for a moment what 2 watts, acting night and day for seven days, will accomplish. That amounts to *900,000 foot-pounds* of work, as compared with 50 foot-pounds for grandfather's clock. If the same energy were applied to raising a weight, it would raise one ton through a distance of 450 feet, as compared with raising 10 pounds through a distance of 5 feet for the grandfather's clock. Conversely, if the clock is driven by the descent of water through a generator, then (disregarding losses) it would require a ton of water falling through more than two and one-half times the height of Niagara Falls to drive just one little clock for one week. Every electric clock that takes 2 watts to drive it consumes more than one-third of a kilowatt-hour of energy per week. Not much, and not very expensive. But if there are ten million such clocks in operation in this country (and that is a conservative estimate), then in one year we expend about 200 million kilowatt-hours just to keep the time. At the low

(Continued on Page 23)

Pebbles as a Stimulus to Scientific Thinking

• By Lawrence Whitcomb, Ph.D. *(Princeton University)*
DEPARTMENT OF GEOLOGY, LEHIGH UNIVERSITY, BETHLEHEM, PENNSYLVANIA

To teach simple geological facts you need not be a trained geologist.

Pebble studies, which require no expensive equipment, encourage student interest in geology, a science too many people know too little about. The studies may be used to illustrate methods of scientific reasoning and research. Very simple problems may be chosen at first, and increased in difficulty as circumstances permit.

This article contains excellent teaching suggestions for use in the field or in the classroom and shows how students may be made curious about the geological formations of their district.

Pebbles are one of the commonest of geologic phenomena and one of the most widespread, yet they are seldom appreciated. To the average child they are handy-sized pieces of rock that can be thrown, sometimes with remarkable accuracy. Flat pebbles seem to have been made to skip upon the waters of a quiet pond. Round pebbles are ideal ammunition for a slingshot. Any pebble will do to throw at a cow that is slow in returning to the barn at dusk. Most people, both young and old, have found that a pebble which was close at hand was just the thing needed at that particular moment, be it to scare a dog out of the newly planted flower garden or to drop into a well as a means of estimating the depth to water.

It is the exception rather than the rule when someone picks up a pebble and asks the questions: how did it get here, where did it come from, and why is it this shape and size? When such questions are asked, they are the sign of an inquiring but not necessarily a scientific mind, for unless an attempt is made to solve the riddle, the questions might as well not be asked. If, as happens in the rare case, the urge to solve the problem leads to careful and thoughtful investigation, the questions were worth while and have opened the way to scientific thought.

Because of the widespread abundance of pebbles and the ease with which they can be collected, they offer an excellent means of interesting young people in the methods of scientific research and also in geology. Pebble collections are also useful in showing the many ways in which a problem, which at first seems very simple, can be studied. One way to stimulate interest in a problem of this type is to ask each member of the class to bring in ten pebbles, not specifying how or where they are to be collected. When the pupils have their collections in front of them, a few well chosen questions will start the discussion.—Does anyone have ten pebbles that are all alike in size, shape or color? Does anyone have ten pebbles that are all different in size, shape or color? Who picked all ten pebbles up at one place, and who picked them up from several localities? If they all came from the same place, are they all similar, or if they came from various places are they different?—When the individual collections are combined, the similarities and differences may become more noticeable. It is then easy with student aid to choose topics for further study and to assign specific problems. While one student is making a collection to show the various types of rock, another can be working on shapes, while a third may try to correlate shape and rock type, and a fourth may try a percentage analysis by shape or rock type at a certain locality. In any one region there are numerous other methods of approach that can be investigated.

A pebble is nothing but a small piece of some preexisting larger rock mass, but it may tell a fascinating story to one who is willing to pry into its history. Sometimes the pebble is found in a stream bed, sometimes on a beach. Sometimes it may have been consolidated with other pebbles and sand to form a new rock, a conglomerate, but always there is a story to be unraveled.

Over a hundred years ago Oliver Wendell Holmes wrote a poem, "The Dorchester Giant," about a conglomerate that is found around Boston. In this poem he tells of a family of giants who threw their plum pudding over the surrounding hills where it hardened, the plums becoming the pebbles in the conglomerate. This is interesting fantasy, but in "The Professor at the Breakfast Table" Holmes became more inquisitive as is shown in the following quotation:

> "I wonder whether the boys who live in Roxbury and Dorchester are ever moved to tears or filled with silent awe as they look upon the rocks and fragments of 'pudding-stone' abounding in those localities. I have my suspicions that those boys 'heave a stone' or 'fire a brickbat', composed of the conglomerate just mentioned, without any more tearful or philosophical contemplations than boys of less favored regions expend on the same performance. Yet a lump of puddingstone is a thing to look at, to think about, to study over, to dream upon, to go crazy with, to beat one's brains out against. Look at that pebble in it. From what cliff was it broken? On what beach rolled by the waves of what ocean? How and *when* imbedded in soft ooze, which itself became stone, and by-and-by was lifted into bald summits and steep cliffs, such as you may see on Meeting-house-Hill any day—yes, and mark the scratches on their faces left when the boulder-carrying glaciers planed the surface of the continent with

(Continued on Page 25)

What is Good Supervision?

• By George W. Hunter, Ph.D. *(New York University)*
THE CLAREMONT GRADUATE SCHOOL, CLAREMONT, CALIFORNIA

The right kind of teacher welcomes the right kind of supervision. It helps him develop professionally. But hit-or-miss guidance and evaluations based on flash impressions rather than on serious and orderly study, are far too prevalent.

In the plan described here for evaluating the teacher and his ability are concentrated the knowledge and wisdom and skill and good sense developed during a lifetime of teaching and supervisory experience.

The writer is a distinguished educator and author, and an outstanding developer of competent teachers of science. For some years his "Science Teaching at Junior and Senior High School Levels" has been the leading textbook of its kind.

We regret to report the recent death of Dr. Hunter. He will be deeply mourned.

After fifty years of teaching at secondary, college, and graduate school levels, with much of the time directed to the supervision of teachers or teachers-in-training, one would think that the writer might successfully answer this question. Certainly he can tell out of his own experience what is *not* good supervision. He has seen much of this sort of thing, beginning with his early days as a young teacher in a large high school. How he used to hate to see the "old man", as his principal was disrespectfully called, sneak in through the rear door of his classroom, sit down for a few minutes, meanwhile scribbling notes in a small book, and then disappear without a comment. That kind of supervision was irritating and was worthless from the young teacher's viewpoint. He wanted help, not hidden criticism. But this was the sort of criticism one got forty-odd years ago in one of the best secondary schools in the United States.

Little wonder that when the writer was considered a superior teacher and was promoted to become head of a department of some twenty-odd teachers, he determined his supervision would be constructive, and that the teachers in his department would feel that supervision was not unjust criticism. So he drew up a code in which supervision became a part of the teacher's business as well as that of the supervisor.

Supervision, if it is to be of any value, must be an exchange of ideas between teacher and supervisor. Most teachers have ideas and many of them know how to use them. Often their ideas on how and what to teach may be just as valid as those of their supervisor. Teachers should have opportunity to present their side of the case. So our first premise in good supervision is that after a supervisory visit the teacher should have an opportunity to talk over, point by point, the criticism of his supervisor.

This meeting between supervised and supervisor should take place as soon after the classroom visit as possible; certainly while the details of the visit are still clear in the minds of both parties. The comments of the supervisor should be in writing and should be entirely open to the teacher. For this reason a supervisory sheet should be used which can easily be checked by both supervisor and teacher at a later meeting when the visit is discussed. Such a sheet, the result of many years of supervision, is shown here. This sheet is made out for use with teachers-in-training, but it is similar to the one used by the writer in supervising high school teachers of biology.

In a recent survey made in California, supervisors were asked what they considered the most important items to be checked in the supervision of teachers. A very large percentage considered the personality of the teacher as being of primary importance. Just how the supervisor is to grade personality is one of the most difficult problems of supervision. Personality is such a big item; think of what it embraces: appearance; voice; disposition; leadership; creativeness, scientific objectiveness; standards of accomplishment; responsibility; tact and, most of all, a sense of humor. How can the supervisor touch on all of these items in a single visit? Obviously he cannot. This means that several visits must be made, especially to the beginning teacher, before personality can be discussed. But as the result of these visits one or more items can be talked over so that eventually the teacher will get some real notion of whether he or she belongs in the ranks of the teaching profession. It is the supervisor who must in the long run be able to show the teacher supervised whether or not he is fit to continue in his job. It is the work of the supervisor to show tactfully that teaching is more than a job, that it is a calling, and that only those who hear the call should become teachers. And that call is from the children who are taught. For the prospective teacher should first of all love children. Subject-matter minded he may be; but if he does not love children more than his subject then he will not measure up to the teacher whom each of us reveres as being the one person who made an impression on our youthful minds and led us gladly up the steep hill of knowledge. Mark Hopkins at one end of the log and the student at the other is the real goal of teaching. ●

REPORT ON CLASSROOM ACTIVITIES OF TEACHERS IN TRAINING

Report on.............................. Date..................

TYPE OF EXERCISE: Drill, problem, topical development, lecture, laboratory.
Underscore the one used.

	Satisfactory	Unsatisfactory	Suggestions
I. GENERAL CONDITIONS. ROOM temperature			
ventilation			
lighting			
orderly disposition of materials			
II. TEACHER. firm			
neat			
posture			
voice clear			
voice well modulated			
sympathetic			
enthusiastic			
showed initiative			
III. CLASS CONTROL. control at beginning of period			
devices for taking attendance			
objective			
use of pupils in distribution of materials			
materials at hand			
economy of time in handling materials			
prompt beginning			
dismissal under control			

	Not noted	Not at all	Slight	Medium	Notable
IV. TEACHING ABILITY AS SHOWN BY *(a) Classroom methods* clearness of aims					
clearness of presentation					
organization of subject matter					
choice of subject matter					
accuracy of subject matter used					
provision for individual differences					
problem solving attitude					
efforts to teach independence in study					
measures to test learning					
(b) Extent to which teacher's questions are thought-provoking					
calling for facts					
suggesting the answer					
answered by "yes" or "no"					
irrelevant					
not definite—vague					
(c) Extent to which material for recitation is confined to text					
within pupil's comprehension					
related to children's lives and experiences					
adapted to children's present or future needs					
worth while					
(d) Extent to which the teaching is rambling					
is formal, mechanical					
stimulates initiative of pupils					
requires independent thinking					
develops pupil's resourcefulness					

(d) Continued	Not noted	Not at all	Slight	Medium	Notable
requires cooperation of pupils					
is fixed on essentials					
requires pupils to organize material					
utilizes children's experience					
clears up pupils' difficulties					
shows use of material in solution of present or future problems					
(e) Extent to which pupils had a clear idea of purposes of lesson					
showed initiative					
tested their own solutions					
acted and thought on their own account					
cooperated with teacher and classmates					
persisted in getting desired result					
differentiated between essentials and non-essentials					
organized their material					
seemed well-grounded in previous work					
showed discipline through interest					

V. WAS THE ASSIGNMENT	Yes	No
definite and clear		
related to present lesson		
such that the pupils were prepared to attack it intelligently		
formal, from text book		
by topics or problems		
hastily made at dismissal		
omitted		

VI. 1. NUMBER OF PUPILS IN CLASS APPEARING TO BE

interested .... indifferent ....

energetic .... lazy ....

independent .... dependent ....

2. RESPONSES OF PUPILS: Number giving

a. fluent topical recitation ....

b. word or phrase responses..........................

c. sentence responses ....

d. incoherent responses ....

e. failing to answer .... (if large number, then look into mentality of class.)

3. NUMBER OF PUPILS ASKING QUESTIONS OF FACT...

NUMBER OF PUPILS ASKING RELEVANT THOUGHT-PROVOKING QUESTIONS ....

	Yes	No	Min.	Illustrations
VII. TIME LOST. (Check X under yes and no.) taking roll				
dismissing class				
distributing materials				
indistinct speech of teacher				
indistinct speech of pupils				
unnecessary talking of teacher				
unnecessary talking of pupils				
failure to have devices ready				
use of ill-adapted devices				

Praise	Helpful Suggestions

After .... weeks of teaching.

Position ....

Signed ....

Little Red Schoolhouse Wired for Sound

• By Victoria Corey
EDUCATIONAL DIRECTOR, RADIO STATION KDKA, PITTSBURGH, PENNSYLVANIA

The teacher who relies solely on the programs she brings into the classroom is using radio to but small advantage. Well chosen programs can be more valuable than textbooks written yesterday. Radio helps the listener to find his relationship to the swiftly moving events around him. Students who study by radio are permitted to keep illustrious company.

These and many other helpful ideas are embodied in this paper written by the experienced Director of the KDKA "School of the Air," a teaching project long maintained by the world's first broadcasting station.

With radio sets outnumbering toothbrushes in daily operation, the technique of listening rises to top importance in our list of atomic age skills. The unconscious and constant exercise of this ability is one which interests us workers in radio to no inconsiderable degree. Hundreds of thousands of dollars are spent by the radio industry annually to find out what makes people listen, what programs they listen to, and why. Volumes are printed each year filled with facts on listener habits and reactions taken from every intellectual and educational level and every economic background. Even the little red schoolhouse and the modern city structure are invaded as we interrogate the children who listen there. Radio will never take the place of the classroom teacher, but one thing we've found: a good program piped into a classroom, plus an enthusiastic teacher with imagination, bring results in education for living which outrival any textbook ever printed.

For many years before the broadcasting of programs to the classroom was thought of, my small daughter and I listened nightly to "Jack Armstrong, the All-American Boy." Life would have been insufferable for her if she had missed her daily story. I listened because she did, and in the course of time I became quite fond of Jack.

When I first became acquainted with him, he was traveling in India, a strange and beautiful land filled with people excitingly different from those around us here. For the months of his sojourn there my daughter and I devoured Kipling and moved on to adventure stories written by travelers to India. Jack moved on to China. My daughter and I planned the places in China we would visit, the things we would do there, the way we would live.

In the years that followed she went through the early grades of school. The travels of Christopher Columbus and the Portuguese left her uninterested and unelated. She saw no particular merit in them. She learned the dates obediently, traced the routes on the map, and hurried home as soon as school was over to catch Jack Armstrong on the air. For what do you think—gray eyes big and shining—Jack's off to a new and wonderful adventure. He's in a small sailing vessel traveling across the Atlantic. He's not sure where he's going, for he's trying to find a small island that's not even on the map. But Jack knows everything. He's learned to operate all the instruments on the ship. That takes a lot of mathematics, too. He knows the stars so well he can steer the ship by them at night. There was a big storm coming up and his crew were scared and they were threatening to kill him if he didn't turn back. But Jack wasn't scared—not one bit he wasn't. He stood up against them, all those people. And would you believe it, just as he ordered the men back to their positions the look-out shouted "Land!" And when the little ship came closer, it was an island. Not the one he was looking for, but one just as good. It was the island of San Salvador. Jack proved to his men that he could find his way across the ocean and bring the ship safely through all the storms to shore.

The island of San Salvador. Another Admiral of the Sea in a sailing vessel with crew mutinying against him years before had landed on a strange island in the ocean and given it its name, San Salvador. Had it been like that with Columbus? Had he been as brave and wise and skilled as Jack Armstrong? Let's see that map again and trace the journey. Let's sniff the salt breeze. Let's brace our feet against the deck rolling with the waves, shoulder to shoulder with the Admiral, peering into the distance, searching for land. Nerves and muscles tense, we'll brave the mutineers who would turn us back and keep us from finding a New World. Say, let me tell you about the story of Columbus. Would you believe it, he started out in a tiny boat with sails. . . .

You don't remember, you don't care until you *feel* the story, until you experience vicariously the terrors, the hardships, the high excitement, the thrill of endurance and achievement with the achiever. After that, let no one presume to ask the student in the wired, renovated schoolhouse. He was there when it happened. He can recount every day and hour of the entire journey. He even remembers what the savage chief looked like when he came to the shore of this strange island to greet them. Your student has become a part of the ever-flowing current of life and human happen-

(Continued on Page 30)

How Seeds Are Grown and Packaged

• By Robert J. Zoller
STAFF, W. ATLEE BURPEE COMPANY, PHILADELPHIA, PENNSYLVANIA

Growing and packaging seeds for sale is big business.

This fascinating and vitally important industry is too often taken for granted, even by teachers of science. It must be remembered that "Seed is basic, and a flower or vegetable is only as good as the seed it grows from."

The history of American seed growers, their simple beginnings and their subsequent great development, their ideas and methods and contributions, is exemplified in the history of the W. Atlee Burpee Company, one of the pioneers, and now the world's largest mail-order seed company, serving millions of customers annually.

In 1876, the 18-year-old son of a prominent Philadelphia physician prepared a four-page folder entitled *W. Atlee Burpee's Catalogue of High Class Land and Waterfowl* and mailed it to a small list of prospective customers. Shortly afterward he added flower and vegetable seeds to his list of offerings and these soon became his specialty.

In January, 1947, the 73rd annual Burpee Seed Catalog found its way into nearly five million American homes. It is a big 128-page volume crammed full of natural color photographs and offering 390 separate classes of flowers and vegetables ranging from achillea and asparagus to zephyr lilies and zinnias. The flower seed section alone lists more than 1200 different varieties.

It is evident that since the days when Mr. Burpee made his modest start, many changes have taken place in the business of producing and selling seed. Nowadays, vegetable and flower seed production is big business. It involves large areas of land with exactly the right soil and climatic conditions, scientific research, a great deal of intelligent, careful planning, expert guidance and supervision, and a lot of hard work.

The Burpee seeds you plant in your garden may come from any one of a dozen seed farms strategically located to achieve what experts consider ideal growing conditions for the various classes and varieties. Best known of these growing stations are the Fordhook Farms established near Doylestown, Pa., in 1888, (before the U. S. Department of Agriculture had any experiment stations), and long famous as the largest and best known trial grounds in the world.

Many famous varieties were developed, improved, or introduced from these farms—Burpee's Stringless Green Pod bush bean, Blue Bantam peas, Copenhagen Market cabbage; some were given the Fordhook name —Fordhook Bush Lima bean, Fordhook celery, Fordhook Hybrid tomato, Fordhook Famous cucumber, and many others.

Almost as well known are the Floradale Farms located in Lompoc Valley, Santa Barbara County, California. From Floradale came all the marigolds with odorless foliage, all hybrid marigolds, the largest of all zinnias, extra-early asters, and many others including the giant ruffled tetraploid snapdragons, and the first giant all-double snapdragons ever grown from seed.

Under David Burpee (present head of the company and its guiding light since the death of his father in 1915) the company has added other growing stations in Iowa, Idaho, and Colorado, and at Ventura in California. During the war, in order to obtain good hand labor for pollination work, company stations were maintained in Guatemala and Costa Rica. In 1943, a midwestern branch plant was opened in Clinton, Iowa, to serve the midwestern and western states. A wholesale distribution plant for southern dealers and market gardeners is maintained at Sanford, Florida.

After the seeds are grown, harvested, and cured at the seed farms they are shipped in large quantities to Philadelphia or Clinton for packaging and distribution

HOW HYBRID TOMATOES are Produced. Emasculating the female parent.

How Hybrid Tomatoes are Produced. Pollinating the blossom by hand.

to the millions of customers who buy seeds by mail. Incidentally, the high percentage of mail order sales is one of the unique characteristics of the seed business. W. Atlee Burpee discovered many years ago that seeds are ideally suited for sale by mail. Whereas the average customer wants to see, feel, and try on for size most of the things he buys, there is really very little he can accomplish by examining a seed before he buys it. Catalog descriptions of the "finished product" tell him a great deal more.

Packaging, I found out on my first visit to Philadelphia, is one of the major problems of the seed business. As we walked around the big plant the superintendent explained the difficulties.

"You can see what we're up against," he told me. "Nearly 2000 different seed varieties, and all have to be put into packets. One kernel of seed corn is probably twenty thousand times the size and weight of a single petunia seed. Obviously we can't devise one kind of machine to package all our seeds."

He showed me one of the packaging machines in action. "Look at this stuff," he said. He held out a handful of small feather-like seeds. "Marigolds. They're so light and feathery, they won't drop down as they should. They clog the machines."

Flower seeds, I learned, are particularly difficult to package. The machines measure out most seeds either by weight or by volume. The more expensive seeds—petunias, double snapdragons, cyclamen, or even such high priced vegetable seeds as hybrid tomatoes—are sold by actual count.

"You mean somebody has to sit down and count out, say fifty seeds to the packet?"

The superintendent nodded. "We have a counting device that works on some seeds. But with anything as valuable as our new petunia seed—Mrs. Dwight D. Eisenhower, for example, or Colossal Shades of Rose—we have to be exact. We count them by hand. Valuable stuff."

"Like gold dust, eh?"

The superintendent smiled. "Gold is worth about $35 an ounce, isn't it? This Mrs. Eisenhower, our most valuable seed, retails at $2 for a packet of one hundred seeds. The stuff is so small it runs about 280,000 seeds to an ounce. You figure it out."

I whistled. "Why, that's $5600 an ounce!"

"That's right. Enough to buy a black market Cadillac. And maybe a fur coat for the wife besides."

We asked why seed should cost so much. Like anything else, we were told, the price of seed depends on a number of factors—production costs and other expenses, quantity available for sale, and demand. With the new all-double petunias production costs are extremely high because every seed is an F_1 (first generation) hybrid, the result of hand pollination. But even at necessarily high prices these new petunia seeds really sell. The flowers are magnificent and everyone wants to be the first in his neighborhood to grow them.

Speaking of "Mrs. Eisenhower" and other new flower varieties brings us to one of the most interesting parts of the seed business. Perhaps more than for anything else Burpee's is famous for the development of new varieties of vegetables and flowers. For years, Burpee's and other plant breeders have been improving on nature in various ways with the result that life is a lot better for millions of persons who never stop to give it a thought.

Much of the improvement in flowers and vegetables has been accomplished by what is known as special selection. Certain plants, whether mutations ("freaks" with characteristics which breed true) or just specially desirable specimens, are selected for seed, and only the finest, healthiest specimens are saved from generation to generation, until all the seed produce uniform plants with the desired traits.

(Continued on Page 37)

Cooperative Botanical Exploration in Eastern Asia

• By E. D. Merrill, Sc.D. *(Harvard University)*
ARNOLD PROFESSOR OF BOTANY, HARVARD UNIVERSITY, CAMBRIDGE, MASSACHUSETTS

This article is important as a brief but personalized record of many men who have done notable work in a special field; it is interesting because it shows clearly how botanical knowledge is accumulated; it is inspiring because it shows that sometimes much can be accomplished by the scientist with but little expenditure of funds.

The writer has made a continuous study of the plant life of the Philippines, the East Indies, and Eastern Asia while he has been connected officially with the Philippine Government, the University of California, the New York Botanical Garden, and Harvard University. Until 1946, he was Administrator of Botanical Collections and Director of Arnold Arboretum at Harvard.

Here he tells something of his own work as he outlines the accomplishments of the early Chinese, the Jesuit missionaries of the 16th century, the Protestant missionaries in later years and, more recently, of staff members of institutions of higher learning in China and throughout the world.

●

Our early knowledge of the tremendously rich flora of Eastern Asia was derived from a great variety of sources. It is fortunate that many individuals are interested in plants and in plant life, this being characteristic of many men of all nationalities. From the beginning of the sixteenth century to the present time it has been, to a large degree, the individual interests of a great number of men on the ground, as it were, to whom we are indebted for our present knowledge of the plant resources of this vast region. They include missionaries, resident business men, explorers, casual visitors, government employees, consular officials, practicing physicians, army and navy officers, and others, all, from one standpoint or another, intrigued with plants.

In the early years the interest centered very largely on plants of economic importance, including those cultivated for food, and those yielding drugs, dyes, fibers, oils, resins, and other products. The pioneer European visitors to China did not overlook the ornamental species, for through their efforts a great many of the native and cultivated species of China were introduced by them into European gardens. Later, following the establishment of the simple Linnaean system of classification in the middle of the eighteenth century, interests broadened, and from then on the leading European herbaria were greatly enriched through vast collections of botanical material definitely prepared for study purposes and transmitted by residents of China to this or that institution for study and report.

It should be remembered that the Chinese themselves had, from a very early date, assembled a vast amount of knowledge regarding plants and their uses. The earliest Chinese publication on botany, the Chi Han *Nam fang ts'ao mu chuang* [Account of the flora of the southern regions] was published about 290 A.D., but there are certain records much older than this, such as the *Chou Kung*, its author unknown, dating from the third century B.C. These early Chinese records have been admirably summarized in Bretschneider's remarkable *Botanicon Sinicum* (1882-1896), and the data included in them, of course, recorded in Chinese characters, are now more or less available through the efforts of various sinologues who have considered these early works. A problem here is, of course, the identification of these early descriptions in terms of modern scientific nomenclature; yet in a high percentage of individual cases it is quite evident from the descriptive data supplied, the local names used, and the illustrations, when these were provided, what these early Chinese authors intended by this or that entry. These early records are of importance, once correctly interpreted, in relation to various problems regarding plant distribution, for they are among the very earliest recorded data in printed or published form.

The earliest records in European languages are those compiled through the efforts of the early Jesuit missionaries beginning about 1550, other than the casual mention of a few plant species in the classical *Travels of Marco Polo*. I mention here the names of Fathers Ricci, Gonzales de Mendoza, Maffei, Trigault, De Semedo, Martin, Boym, Le Comte, and, for the Philippines, Kamel, in whose honor the generic name *Camellia* was later selected. Their published works were, for the most part, not botanical treatises, for they concerned themselves largely with plants of economic importance, exceptions being Boym's *Flora Sinensis* (1665), and the extensive botanical work of Kamel, published in London in 1702 and 1709. The botanical work of the pioneer Catholic missionaries has been continued and intensified, to mention only a few following the pioneer era such as Fathers Incarville, Cibot, Gaubil, and Loureiro, for the eighteenth century, and the very remarkable list for the nineteenth century including Fathers Guillamin, Guillin, Debeaux, Perny, D'Argy, David, Heude, Delavay, Bon, Bodinier, Soulié, Faurie, Farges, and Giraldi. Enormous botanical collections were made, especially by Fathers David, Delavay, Farges, Soulié, and Faurie, who worked in close cooperation with the

botanists of the Muséum d'histoire naturelle, Paris, and who operated very largely in previously unexplored parts of China as far west as Szechuan, Yunnan and Tibet. Their extensive field operations made the Paris institution, for the time, the great center of botanical research on the Chinese flora. As a matter of fact the expenses for some of the very long trips, such as those of Father David, were covered by grants from the Muséum d'histoire naturelle, an early example of cooperation in the sense that I have developed it in the past two decades. The names of these Catholic missionaries are written large in the history of Chinese botany and botanical exploration.

Beginning at a somewhat later date were the botanical efforts of various Protestant missionaries, and still later staff members of various institutions of higher learning established here and there in China. Their operations date from the early part of the nineteenth century, and among the names worthy of mention are Messrs. Vachell, Krone, Williamson, Peirson, Graves, Campbell, Ross, Chalmers Moule, Nevin, McCarthy, B. C. Henry, and Webster. They, like their Catholic contemporaries were interested in plants, and the collective efforts of these men helped to build up our fund of knowledge and the great reference collections now available. From my own experience I have felt that if an individual, located in a strange land, with few associations with members of his own race and creed, is fortunate enough to develop a hobby in some branch of natural history, that this extra-curricular interest goes far in increasing his efficiency and in what he is attempting to consummate. It is a good safety valve, as it were, and from a purely psychological standpoint, is distinctly worthwhile.

The nineteenth century development of our knowledge of the flora of China was very remarkable. By no means were only the missionaries involved, striking as were the contributions of some of them. We might cite the botanists and collectors associated with various official exploring expeditions sent out under the auspices of the governments of Great Britain, France, Germany, Sweden, Austria, and the United States in the first half of the century; the field work of certain staff members attached to such embassies as those of Macartney (1793) and Amherst (1816-17); the extensive field work prosecuted by botanists and collectors sent out by such organizations as the Royal Horticultural Society, and by some of the larger botanical establishments of Europe. The efforts of these men were remarkably supplemented by the field work of a long list of local residents, including employees of the Chinese customs service, consular officials, army and navy officers, business men and their employees, teachers, and others. Most worthy of mention in this broad category are Messrs. Hance, Hinds, Harland, Callery, Grijs, Wilford, Potts, Champion, Reeves, Williams, Forbes, Hancock, Hosie, Bourne, Fortune, Sampson, Swinhoe, Oldham, and Playfair, and earlier, Osbeck and Toreen. It is interesting to note that the names of many of the men mentioned above are perpetuated in generic designations for certain striking groups of plants in such names as *Davidia*, *Delavaya*, *Incarvillea*, *Faberia*, *Henrya*, *Bournea*, *Sheareria*, *Bowringia*, *Reevesia*, *Pottsia*, *Hancea*, following the Linnaean idea of so perpetuating the names of some of the individuals who assisted him in building up his own collections of Chinese plants, in *Osbeckia*, *Torenia*, and *Lagerstroemia*, named for Pehr Osbeck, Olaf Toreen, and Magno de Lagerstroem, respectively. These are individuals in various walks of life that professional botanists have been delighted to honor because of their services to the science.

The interests of the numerous early explorers of China were thus very greatly diversified, but they all had one interest in common, that is in plants and in plant life. Some were actuated by mere curiosity regarding this or that plant they observed, and others had a deep and abiding interest in systematic botany and in floristics. Some of them published extensively on their own collections, but for the most part the material assembled here and there by this or that individual was transmitted to institutions in Europe and in America for study and report. Many were naturally interested in ornamental plants, and through their efforts many hundreds of species became established in European and American gardens through the medium of living plants and packages of seeds forwarded from time to time; for in the early days there were no restrictions in the form of our modern plant quarantine, and living plants could easily be shipped in Wardian cases.

My own interest in the floristic problems of China was derived from my earlier work in reference to the vegetation of the Philippines between the years 1902 and 1923. It was soon realized that the Philippine flora could not be explained on the basis of Philippine collections alone, and gradually the field was extended to neighboring regions, such as Guam to the east, Amboina to the south, Borneo to the immediate southwest, Indo-China, and Southeastern China, and a serious effort was made to build up a large reference collection of plants from all of these and other contiguous areas, especially for the entire Indo-Malaysian region of which the Philippines form a part. This finally led to personal field work in China, first in Kwangtung Province, and later to the lower Yangtze Valley with Nanking as a center. This personal experience convinced me that much more could be accomplished by cooperation than through personal field work, which naturally had to be limited to vacation periods of a month or so at a time.

It should be remembered that up to about 1915 there were no trained Chinese botanists. All previous work on the flora of China, both in the field and in the larger botanical institutions of Europe and of America, had been accomplished by foreigners. Then various young Chinese students became interested in the subject, the first to secure advanced training selecting Harvard University for this purpose. These pioneers were Messrs. S. S. Chien, H. H. Hu, and W. Y. Chun, the

(Continued on Page 35)

Aviation and World Health

• By H. M. C. Luykx, D.Sc.
ASSISTANT PROFESSOR OF PREVENTIVE MEDICINE, COLLEGE OF MEDICINE, NEW YORK UNIVERSITY

The development of aviation introduced new problems of health and sanitation that are causing concern throughout the world.

One of the most effective barriers against the transmission of disease—distance in time and space—has been removed. But medicine and science have developed effective measures that are now being taken to prevent the spread of communicable disease through air travel.

This account of how certain feared diseases are kept from gaining entrance here was written by an outstanding leader in the work of prevention. It may set your mind at rest.

●

Aviation ranks high among the forces affecting the progress of civilization. That this particular force is not a hundred per cent to the good results partially from problems concerned with world health and the control of communicable disease. These problems are by no means alarming, however, and in the last analysis it will be *because* of the great benefits of air travel, and not in spite of them, that conditions of health and sanitation will be increased throughout the entire world.

In history, technological improvements in methods of manufacturing and of conducting trade have brought with them new problems in the control of disease. These new problems have without fail been followed rapidly by new solutions. Early development of commerce accross the Mediterranean introduced disastrous epidemics into Europe. Plague, typhus and smallpox in the "Dark Ages" were scourges of a force unknown today. Quarantining was resorted to as an attempt at control, with undoubtedly a certain measure of success, even though in the light of present day knowledge early concepts of illness consisted of little more than superstition. With the advent of the airplane we again have problems in disease control not encountered before. But with the high degree of attainment not only in the medical sciences, but in social, economic and political organization as well, solutions are being effected before dangerous conditions can come into existence.

That the world has become smaller, as it has by reason of aviation, is not an unmixed blessing. Distance, in space and in time, is probably the most effective barrier to the transmission of disease. It is a function of air transportation to minimize such distance in both respects. The result is that: (1) among persons living closer together there is increased probability of communicating a disease from one to another, and (2) reducing the time of travel from one place to another introduces a very special hazard of transmission, related to the incubation period of an infection.

The incubation period is the time required for symptoms to develop after the infectious agent has been transmitted to its victim. For example, cholera, which has an extremely short incubation, may exhibit its specific symptoms within a few hours of the infection, or it may take five days before recognizable symptoms appear. For influenza, the incubation period may be as short as one day or as long as three days. For plague or yellow fever it may be anywhere from three to six days. For yaws, filariasis, and leprosy it may be a matter of months, and even years.(1)

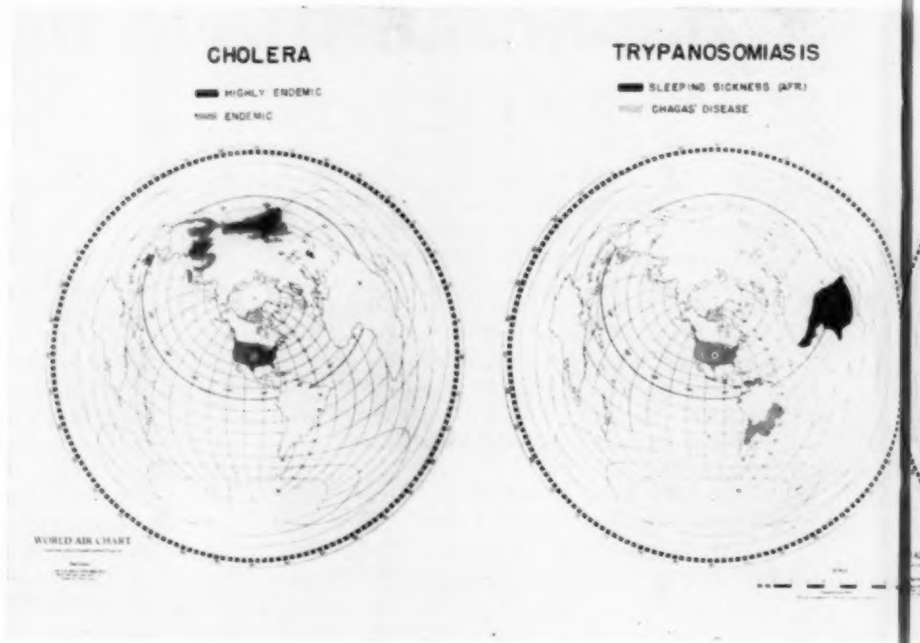
In the past, particular attention has been accorded five diseases—cholera, plague, yellow fever, typhus and smallpox,—because of their severity and the ease with which they are transmitted. The maximum incubation period for smallpox is fifteen or sixteen days. The others generally have shorter periods. Hence the risk of transporting a disease from one continent to the other was not great when it took from two to four weeks to travel from Asia to Europe or to America. Even if a person were infected just before sailing, he would be most likely to proceed through his incubation period so that upon arrival he would have definite symptoms. Although of no benefit to the patient, this fact would make it possible to protect the community to which he was traveling.

At present the situation is different because convenience of travel means that more persons move from place to place, and travel time has been reduced so that one's destination is frequently reached before the incubation period has elapsed. A person may unwittingly be infected with smallpox, let us say. If he then boards a plane and arrives at his destination in two days, neither he nor anyone else knows that he is harboring a disease. He may proceed from the airport to his home, and then come down with the prodromal stage of his illness—that stage with general symptoms such as a simple cold might produce, but which is the stage of the disease when it is most easily spread from one person to another. This may give him no great concern because he still does not have the specific symptoms which would warn the physician that there is a dangerous communicable disease present. By the time the local doctor discovers that he is dealing with a case of smallpox, the damage will have been done and a minor epidemic may have been started.

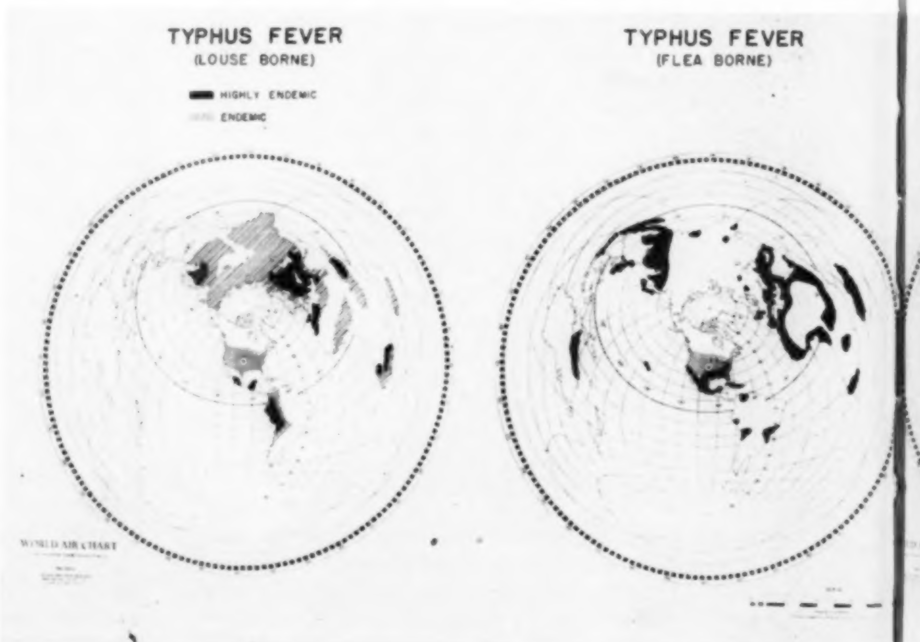
The recent experience in New York City was the result of transportation by bus. A business man arrived from Mexico, felt sick and stayed in his hotel for nearly a week. He was then admitted to a hospital and died two days later—of smallpox. During his illness the disease was unrecognized so that a dozen other persons were infected, causing at least one more death.[2, 3] In view of the length of the incubation period for smallpox, the story might just as easily have involved air transportation from a more distant part of the world. In the United States the danger of a severe epidemic may not be great. Here most persons are either vaccinated or can quickly be reached for immunization, as was done for five or six million New Yorkers. But suppose this happened in India or China. Epidemics there are almost commonplace.

The first solution which might present itself would be to detain any suspected individual (and this should perhaps include any individual coming from a suspected area), until even the longest incubation period would have been completed. Obviously this is not very practical from the point of view of travel by air. The advantage of traveling by air is that you will get there sooner, and a regulation which would then keep you from going about your business for another week or two would destroy this advantage.

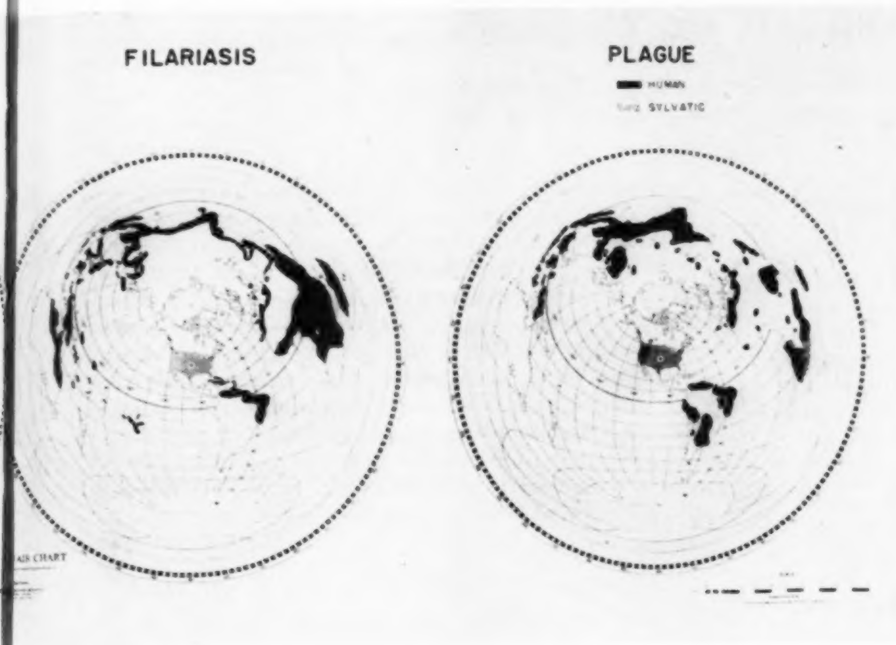
Realizing these difficulties, public health officials of the various nations in the world have studied this problem extensively. The result has been the International Sanitary Convention for Aerial Navigation, done at The Hague in 1933.[4] This Convention promulgated a set of rules designed to prevent the spread of communicable diseases through air travel without inconveniencing the passengers and the transportation agencies more than a necessary minimum. The Convention was modified in 1944,[5] to incorporate the results of experience with air travel, and newer knowledge concerning certain diseases. At first, the five diseases mentioned above—cholera, plague, yellow fever, typhus and smallpox—were the only ones on which specific



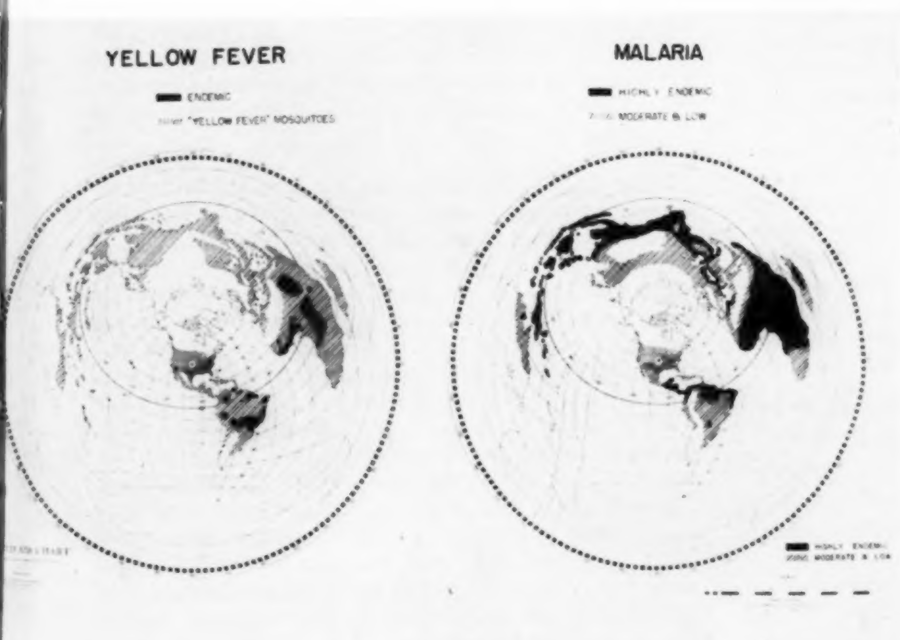
★ ★ ★ ★



Charts adapted by the writer from Simmons et al.[6] U. S.-centered azimuthal equidistant pr ts a tion maps by Air-Age Education Research (copyright American Airlines, Inc.)



★ ★ ★ ★



prts adapted by the writer from Simmons et al.[6] U. S.-centered azimuthal equidistant projection maps by Air-Age Education Research (copyright American Airlines, Inc.)

control was attempted. This has been modified to include any communicable disease which might in the opinion of proper authorities be a menace to health. In 1933, special measures to prevent the spread of yellow fever consisted chiefly of the elimination of mosquitoes from airports and the detention of individuals who were likely to have been infected before embarking on a plane. Now a fairly reliable vaccine against yellow fever has been developed. A person who can prove he was vaccinated need not be detained, and by proper vaccination of airline personnel it is no longer essential to keep a plane from landing at an airport which has not been entirely mosquito-proofed. The prevention of the spread of disease throughout the world is not so much a matter of isolating an individual who may have been infected, as of encouraging immunization, and of gaining a knowledge of where certain diseases exist. Thus, for example, specific measures for the prevention of plague need not be instituted if an individual comes from an area where we are sure no plague exists.

The military efforts of the recent war have provided us with a great deal of knowledge regarding the geographical distribution of communicable diseases. In contrast to the situation many years ago when persons did not know the cause of many illnesses and therefore did not know where they might occur without warning, we now have maps to show us where specific danger areas exist. Prevention of the spread of infectious disease is no longer a matter of shooting in the dark.

The accompanying figures[6] show the geographical distribution of certain communicable diseases in relation to their distance from the United States. Cholera and trypanosomiasis (African sleeping sickness) exist only at some distance from our shores. All the other diseases shown are present either in our country or among our Latin American neighbors. As we have seen, distance is no longer a barrier, so that prevention of transmission of

(Continued on Page 32)

Forty Years of Research on Liquids

• By George Antonoff, D.Sc. *(University of Manchester)*
DEPARTMENT OF CHEMISTRY, FORDHAM UNIVERSITY, NEW YORK CITY

Teachers of physics and chemistry should study this paper, not merely give it a quick reading. It may open new vistas.

In it they will find a discussion of the physicochemical evidence that indicates that liquids have definite structures. A theory is outlined that explains the baffling fluctuations in the physical properties of liquids, and shows why careful measurements of their physical constants made by competent workers do not always agree.

This paper was written by a friend and coworker of Lord Rutherford, Sir Arthur Schuster, J. W. Nicholson, and their noted scientific contemporaries at Cambridge and on the Continent in the early years of the twentieth century.

I have been engaged in work on liquids for nearly forty years, with some interruptions. I have chosen a path entirely different from the conventional approach to the subject. I started with some objectives in view and arrived at results entirely different from what I expected.

The difficulties I experienced at the very beginning were discouraging because they created an impression of unsatisfactory work. Only much later did I realize that it was not my fault, and that all the trouble was due to intrinsic causes, namely, to the existence of structures in liquids. It manifested itself in the first instance in disagreement between individual measurements. If one compares constants given by various authors, one observes differences well above what can reasonably be assumed to be the limits of experimental error. This is not due to poor work or to lack of conscientiousness on the part of most of the authors. The fact is that a liquid cannot have any definite properties assigned to it, unless its previous history is known. At a given temperature, certain equilibria set in, and when the temperature changes it may be some time before the liquid has adjusted itself to the new temperature.

It was some time before I began to understand these things, and it may perhaps interest others to know how this took place.

My research on liquids originated in the following way. In a test tube I saw two liquid layers, such as ether and water, and I asked myself why they did not mix. The answer could not be found. The idea came to me that it had something to do with surface tension. With this idea in mind, research was started which indicated that there exists a definite law connecting the surface tensions of the two liquid layers with the interfacial tension. Prior to that, general evidence had indicated (Quincke) that there was no relation of any kind between the quantities mentioned. This was due to the fact that prior experimentalists had paid no attention to conditions of equilibrium. In this sense, one cannot minimize the great importance of the ideas of Willard Gibbs who explained to the world that unless conditions of equilibrium are strictly observed, no physical measurement can have any definite value.

In a limited number of pairs of liquids I succeeded in showing that a relation

(1) $\gamma_{12} = \gamma_1 - \gamma_2$

where γ_1 is the surface tension of one liquid layer

γ_2 is the surface tension of the other liquid layer

γ_{12} is the interfacial tension

holds true. It will be called hereafter A.L. *(Antonoff's Law)*. It was found that if one or both liquids are volatile, it is extremely difficult to maintain equilibrium, and special techniques had to be worked out for these studies. In spite of that, in a number of cases, figures were obtained which fluctuated with time. No explanation of any kind could be found for these phenomena. A comprehensive theory was needed, and as it was not available it was futile to continue this work. I therefore decided to abandon the research, at least temporarily. Just at the same time, I found out later, Lord Rayleigh also decided to give up his research on the same subject. He obtained no results for the same reason as Quinke, that is, because the ideas of Willard Gibbs were alien to him, and he did not approach the subject from the point of view of equilibria.

I then went to work with the late Lord Rutherford on radioactivity—an entirely different subject. However, when Rutherford announced his theory of the atom, it became clear that surface tension must be due, in some way, to electrical forces. Sir Oliver Lodge expressed the view that surface tension can be due to electrical dipoles. I then felt it was time for a new theory of surface tension to be evolved. Being encouraged by the late Ph-A. Guye of Geneva, a great specialist on liquids, and by Sir Arthur Schuster, I went to Cambridge. There J. J. Thomson placed me in contact with J. W. Nicholson, who was regarded as the most prominent mathematical physicist of the day. With his help, a theory of surface tension was worked out on the assumption that molecules are electrical or magnetic doublets or both. This work was done in 1911-1912 but could not be published until 1918[1] due to the war. In the meantime, in 1912, Debye introduced the concept of dipole moments due to excentricity of the electrical charges in the molecule.

My theoretical work showed that formula (1) can actually be deduced theoretically, and curiously enough, it indicated that two liquid layers in contact with each other can coexist only if they contain an *equal number of molecules* (or better, particles) *per unit volume*, that is, when

$n_1 = n_2$
where n_1 is the number of particles per unit volume in one liquid layer and n_2 is the number of particles per unit volume in the other liquid layers.

This result seemed puzzling to me at first, but every possible experimental evidence accumulated since then shows it must be so. It also shows that the laws of kinetic theory do operate when applied to liquids in spite of the short distances between the particles. This indicated that in liquid-liquid systems (those which consist of two superimposed liquid layers) there must exist together with simple molecules, some molecular aggregates of a high degree of complexity. This was the first evidence in my experience showing that liquids are endowed with a definite structure.

The physico-chemical evidence corroborating the above view is the following:[2]

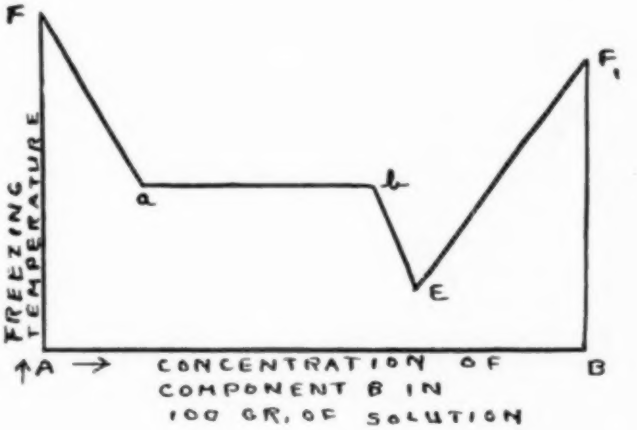


FIGURE 1

The freezing point curves of two component systems showing separation into two liquid layers are of the type shown in Fig. 1. The freezing temperature of the component A, called F, is lowered on addition of component B until point *a* is reached. At this point the second layer appears. Up to that point the solution was homogeneous, but beginning at *a* it contains two phases so that on shaking it forms an emulsion. On further addition of B the freezing temperature remains constant until point *b* is reached. In the interval between *a* and *b* only the relative volume of the two layers changes and at *b* only the second layer is present. On further addition of B the freezing temperature goes down until temperature E—the eutectic point—is reached. In all these experiments, before E was reached it was the component A which separated as ice. At the eutectic point E, A and B form two ices coexisting together as separate entities. Between E and F_1 (the latter point being the freezing temperature of the component B) the substance B separates as ice. We are therefore justified in saying that all solutions on the left hand side of E, separating the same ice of a pure substance A, are *solutions in the solvent A*. All solutions on the right hand side of E are *solutions in the solvent B*, because B separates as ice. The fact that the solutions at points *a* and *b*, situated on the same side of the eutectic point, are solutions in the same solvent is very important to the theory. These two concentrations, forming two superimposed liquid layers in equilibrium with one another have also the following characteristics:

1) They freeze at the same temperature.
2) They boil at the same temperature.
3) They have the same vapor pressure.
4) They are iso-osmotic, that is, they have the same osmotic pressure.

These four properties are the so-called colligative properties—those which depend on the *number* of particles in solution and not on their nature. This picture explains well why the two solutions, forming two layers do not mix. If they are iso-osmotic and the laws of kinetic theory operate, nothing else can be expected. Thus the condition deduced at first mathematically that $n_1 = n_2$ receives full confirmation from the whole physico-chemical evidence. It always seems unrealistic when first considered, as it did to me, but now I can see that it is an important law of nature.

Such conditions must be due to the formation of some aggregates of high complexity. They differ from ordinary chemical compounds in that they cannot be isolated. They can exist only in conditions of equilibrium. This equilibrium is not necessarily attained immediately after a temperature is established. Thermal equilibrium requires about 20 to 30 minutes, whereas equilibrium in conformity with Antonoff's Law takes days, weeks, or months. The properties of both phases depend on previous history. If the system has been subjected to temperatures higher or lower than that of the thermostat, the properties will *fluctuate* until equilibrium is established. Densities can be measured easily to six decimal places. In these experiments, fluctuations usually show up in the third decimal place. The results obtained are not necessarily reproducible until a state of equilibrium is reached, when the densities acquire definite values within at least three decimal places. With a temperature control of $\pm.005°C.$, fluctuations in the fourth and fifth decimal places apparently persist. It is not yet known whether or not they can be eliminated with better control.[3]

The degree of complexity, obviously, decreases with temperature, (although the reverse is possible in systems which separate into two layers when the temperature is elevated).

Physical properties as functions of temperature exhibit discontinuities at certain intervals.

All the above facts give an excellent approach to the formulation of a general theory of liquids.

Theory of Liquids

The difficulty in the study of liquids is chiefly due to the fact that we have no methods of determining the molecular weight of a substance in the liquid state.

Considerable light can be thrown on the nature of the liquid state by comparing the critical phenomena in liquid-liquid systems with those in liquid-vapor systems. The difference between them is this:

When a solution is cooled below its critical (or consolute) point, condensation of a substance takes place within a solvent and it results in the formation of two liquid phases (a liquid-liquid system). When an individual substance in the gaseous state condenses, separation of an individual substance into two phases (a liquid-vapor system) takes place in a space not otherwise filled, that is, in vacuo.

bria between liquid and vapor can be understood only if it is valid, with all its consequences. Therefore, one can assume that $n_1 = n_2$. This concept conforms to the facts observed below the critical point. There is a temperature below it when the density of the liquid d_l is twice the density of the vapor d_r.

$$\frac{d_l}{d_r} = 2$$

Assuming that the liquid consists of double molecules, it is not difficult to imagine that the gas laws will operate, and the number of molecules in the two phases will be the same. The evidence seems to indicate that the law of multiple proportions is valid, thus

$$A + A = A_2$$

and then a kink in the density curve follows, and an-

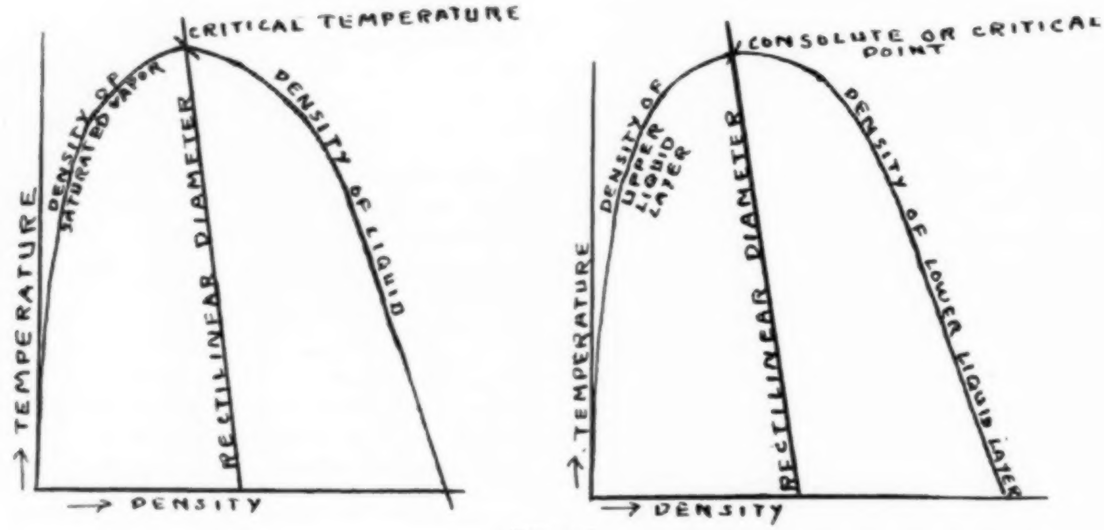


FIGURE 2

The analogy between the two phenomena is very impressive. They both separate into two phases of equal volume; the meniscus of separation is flat; there is no capillary rise in the immediate vicinity of the critical point or several degrees below it. Both systems follow the law of rectilinear diameter of Mathias-Cailletet. (Fig. 2). Physical properties as functions of temperature show discontinuities.[4] All this shows that both systems are subject to exactly the same laws. The advantage of liquid-liquid systems is that full investigation of surface tension relations is possible, whereas in liquid-vapor systems we are handicapped by lack of methods—we cannot measure the surface tension of vapor. But conditions in the critical region just outlined indicate that there A.L. in its special form

$$\gamma_{12} = \gamma_1 - \gamma_2 = 0$$

is valid.

Therefore, there is every reason to believe that it must be also valid at all temperatures, because equili-

other change starts. (The coefficients are not certain owing to inaccuracy of experimental data).

$$2A_2 = A_4$$

After every kink, other transformations with ever increasing coefficients will follow. The ratio $\frac{d_l}{d_r}$ is a measure of the degree of complexity of the molecule as long as the particles are small compared with the total volume occupied. With high aggregates it may be that this ratio is no longer an indication of the degree of association of liquid molecules. In the liquid-vapor case, we cannot take advantage of colligative properties as we did in the liquid-liquid systems. But the nearest analogy to them is the fact that liquid and vapor exercise the same pressure on each other when they are in equilibrium. The equilibrium can be imagined thus: An aggregate leaves the liquid; it disintegrates into simple molecules in the gaseous phase and increases the vapor pressure. The increased pressure causes the molecules to

go back to the liquid where they participate in new aggregate formation.

Fluctuations in properties of aqueous solutions can be observed in the third and subsequent decimal places, and they are big enough to be easily detected experimentally. For example, in a 25-cc. pycnometer one can observe a change in mass of 5 mg. or so, if the volume is brought up to the mark. Prolonged experiment in a thermostat has not produced stabilization under conditions now available. Depending upon previous history, differences in properties in the fifth and subsequent decimal places were found. The same was true for ethyl alcohol. Alcohols with higher molecular weights, such as isoamyl alcohol, showed fluctuations in the third and, occasionally, the second decimal place.

The fluctuations are diurnal, changing from day to day. Thus, in speaking about constants of liquids, one must be very careful.

The above picture can be well supplemented by the evidence of x-ray analysis:

" . . . Individual particles of a liquid do not, like those of a perfect gas, assume at random all possible positions and orientations in space, but their mutual arrangement resembles very largely that of a crystalline state. In this sense we may conceive of the liquid as an aggregate of numbers of very small crystals in which each individual does not show exactly the arrangement characteristic for it in the crystal but assumes a series of temporary positions. These small crystallites (each consists of only 10-100 atom.) are only very short-lived; they disband continually and recrystallize, so that a given particle belongs for an instant to one of these small aggregates, then to none, then to a subsequent one which has been formed in the meantime, and so on. . . ."[5]

The concept just quoted is good in every sense, except one. It does not allow for sufficiently large aggregates as necessitated by other evidence. Here one may invoke the hypothesis made by W. H. Bragg for the solid state. He assumed the existence of secondary structure not revealed by x-rays; many properties cannot be explained unless there is the phenomenon of association in the solid state.

But another corroboration of the present theory can be found in the recent work of Max Born, which can be summarized as follows:

"It is found that the quantum laws governing the behavior of matter in bulk are identical with the classical laws, but the atomistic interpretation of the quantities appearing in the equations shows great deviations from 'classical' liquid behavior."[6]

Thus general evidence by all methods indicates that liquids have a structure. ●

REFERENCES

1. G. Antonoff, Phil. Mag., *36*, 377, (1918); *38*, 417 (1919)
2. G. Antonoff J. Phys. Chem., *36*, 2413, (1932)
3. G. Antonoff, Arch. Bioch., *6*, 199, (1945)
4. G. Antonoff, Z. Phys. Chem., *112*, 461, (1924)
5. H. F. Mark, Physical Chemistry of High Polymeric Systems, Interscience Publishers, Inc., 1940, N. Y., p. 178.
6. Max Born and others, Nature (London) 159, 738-9, May 31, 1947

★ ★ ★ ★ ★

Grandfather Was Not Dumb

(Continued from Page 7)

rate of 1 cent per kilowatt-hour, that means a power bill of $2,000,000 per year to run them. The actual bill is much greater.

Compared with the total annual power bill of the country, two million dollars is small change. The service rendered is undoubtedly worth what we pay for it. But this just goes to show that modern inventions, however desirable, are not always as efficient as older ones, that every new gadget may present us with a new bill to pay, and that we have come to regard even small claims upon the budget of our electrical energy as too insignificant to consider. Small wastes, considered in their country-wide extension, can become appreciable; but so long as we don't bat an eye over expenditures of a million dollars by State governments, or a billion dollars by the Federal government, and so long as we aren't concerned over how we use and conserve our resources of energy, we will doubtless go on disregarding small leaks that sap our strength.

No one admires the ingenuity behind the electric clock more than I do. It is a symbol of the reliability of our great power utilities. It is quiet, convenient, and accurate. But let us not assume that, just because a thing is modern, it is therefore more efficient. Grandfather had a way of saving his energy for useful purposes. He was handicapped by the lack of many of the things we enjoy. Let us remember that nowadays, each one of us can squander energy (for lighting, operating radios, driving automobiles, and the like) at rates far beyond the reach of Grandfather. If, as a result, we are correspondingly more productive, and if we lead richer and more meaningful lives, then the expenditure is worth while. But if our machines are driving us crazy, if in our mad rush to keep up with them we are allowing them to rule us, if we are slowly allowing the radio to take the place of frequent reflective thinking, perhaps we should stop long enough to take stock and consider the use we make of our new resources and inventions. ●

NEW BOOKS

Observation and Study Guide for Student Teachers

• *By* EDGAR M. COOK, Ph.D., and JOHN H. CATES, M.A. Second Edition. St. Louis: The C. V. Mosby Company. 1947. Pp. 167 + 36. $3.50

This is a flexible manual for teacher-education institutions. Its study may accompany, follow, or even precede a general course in methods or principles of teaching. It may be used in supervised student teaching in either the elementary or secondary school. It provides a basis for one or more semesters of student teaching. The arrangement of 36 observation sheets in a separate section makes it possible for the student teacher to record his observations in the order made.

A concise but rather complete statement of objectives and procedures in student teaching introduces the future teacher to some thirty work units which comprise every phase of educational method and principle. Practical in its format as well as in the choice of material, this book harmonizes with the best practices of the present-day school. The authors deserve commendation for this up-to-date revision.

George A. Harcar, C.S.Sp.
Dean, School of Education
Duquesne University.

Electricity, Principles, Practice, Experiments

• *By* CHARLES S. SISKIND, M.S.E.E. New York: McGraw Hill Book Co., Inc. 1947. Pp. ix + 448. $2.60.

This book, written on a senior high school or junior college level, succeeds admirably in presenting the general principles of direct- and alternating-current electricity in a clear and concise manner. The author shows how to verify the fundamental principles by simple experiments, and demonstrates how the principles are applied in modern devices and machines. The sections on magnetism, electromagnetism and electromagnetic induction are especially well done.

The material is well arranged for teaching. Each chapter has a summary, a list of questions, and a number of problems. The 9-page list of visual aids is a noteworthy feature. Numerous line drawings and photographs add to the interest and value of the text *A.K.*

Laboratory Chemistry

• *By* WLILIAM E. PRICE, Scott High School East Orange, N. J. Yonkers, N. Y.: World Book Co. 1947. Pp. x + 133. $0.92.

This consumable laboratory manual contains 48 experiments suited to students of high school age, described in simple terms. There are work sheets which include drill in problem solving, and a number of project experiments designed to stimulate student interest. Although the apparatus required is extremely simple, in using it the student should develop a certain manipulative skill. The order in which the experiments are to be performed is flexible, making the manual suitable for use with any textbook. *H.C.M.*

Pebbles Stimulate Thinking

(Continued from Page 8)

> such rough tools that the storms have not worn the marks out of it with all the polishing of ever so many thousand years?"

Not being a geologist Holmes despaired of solving the riddle, for he continues:

> "A pebble and the spawn of a mollusk! Before you have solved their mysteries, this earth where you first saw them may be a vitrified slag, or a vapor diffused through the planetary spaces."

Since the day of Holmes, geologists and others have accepted the challenge, and although there is still much to be discovered, a great deal has been found out about pebbles. The kind of rock, shape, size and color of a pebble may be easy to discover, but there are many more fascinating problems that a student may investigate.

Where did the pebble come from? If it was found in a stream bed the direction of origin is probably easy to determine, and if there are several types of rock upstream, it may be possible to tell from what part of the valley it came. If there are two or more branches to the stream, the problem becomes more interesting. This is, after all, the same problem that faced the "forty-niners" in California, for when they found gold dust and nuggets (a form of pebble) in a stream, they started to trace them back into the hills trying to find the parent ledge from which they came, and greater wealth.

If the pebble was found on the ocean beach, one has to look both ways to find the rocky headland from which it was derived. In solving this problem, one learns about the coastal currents and the action of storm waves. If the pebble was found in glacial debris, the problem may be insolvable, but numerous well-established "boulder trains" have been traced back to a certain hill or small area. If a new "boulder (pebble) train" is discovered, not only has the problem been solved but a real contribution has been made to glaciology. Even if a distinct train cannot be found, the general direction of ice movement may have been shown and one's knowledge of glacial action has been increased.

The shape of a pebble is often an interesting problem. Why are some so nice and round, while others are flat and skip so well upon the water? What are the differences in the rock that produce this contrast? Why are some well rounded and others quite angular? By walking a few miles along a mountain brook one can sometimes notice a difference in shape and from this deduce the answer. Glacial pebbles are often found with one or more faces that have been ground almost flat while the pebble was held fast in the ice or scraped along the hard bedrock. On modern beaches or in old windblown sand deposits are found faceted pebbles that have had one or more faces ground smooth by nature's sandblast, as they lay embedded in the beach; such pebbles are known as glyptoliths and can make up a very nice specialized collection.

Whatever type of study is made of pebbles, it is sure to bring forth questions and to open new lines of discussion. It teaches the power of observation which is one of the prime requisites of a scientist. No one can study the pebbles of a region without delving into its past history. By a study of pebbles, it may be possible that one or more of the students will discover the fascination of geology as an avocation or an occupation. ●

★ ★ ★ ★ ★

Research in an academic institution has as its major objective the improvement of its principal product—the student. Mere experimentation does not take the place of scholarly endeavor; neither does competence in research, alone, take the place of inspirational teaching, which stimulates people to clearer thinking, greater endeavor, good citizenship and human decency. Research, either in the specialty of the teacher or in teaching methods, is essential to keep the teacher up to date. All good teachers are scholars.

A. A. Potter
Dean of Engineering, Purdue University
Association of American Colleges *Bulletin*
December, 1947

★ ★ ★ ★ ★

Progress in Astrophysics

(Continued from Page 6)

We have not yet reached a complete understanding of the turbulent motions in stellar atmospheres. For example, we do not definitely know whether the turbulent cells are large or are very small compared to the thickness of the entire atmosphere. It was at first suggested that the turbulent cells were relatively small in size so that a great many of them having different motions, could exist simultaneously one above the other. The combined absorptions of all such cells would then reproduce with great faithfulness the best determined curves. However, in recent months several curves of growth have been published, especially by K. O. Wright of the Dominion Astrophysical Observatory at Victoria, B. C., which throw some doubt upon this assumption. Perhaps we should rather suppose that the turbulent cells are not small but are more like a field of dense prominences similar in structure to those of the sun, which surround the stars. Some of these prominences would be moving outward; others would be moving inward. Some might move tangentially to the surface of the star or at different inclinations. However, there is reason to believe that the forces which activate the prominences of the stars are directed mainly along the radii so that the predominant motions would also be inward or outward along each radius. This, if confirmed by further investigations, would indicate that the turbulent motions are not random ones, as had been assumed in the earlier investigations. There might well be a tendency to produce a distribution with two separate maxima, one corresponding to an outward motion, the other to an inward motion. Observations by W. S. Adams at Mount Wilson have shown that such a tendency is indeed observed in several bright stars. For example, in the supergiant Betelgeuse many lines are not simple symmetrical structures as they are in the sun. Instead they have two unequal depressions, one of which corresponds to motions away from the star, while the other corresponds to motions inward.

All of this work would have been relatively unimportant if it were not for the fact that we have finally reached the stage where we can begin to talk intelligently about the abundances of the different elements in the atmospheres of the stars. It has been known for some time that hydrogen is enormously more abundant in the sun and in most other stars than it is on the earth. Roughly speaking there are 10,000 hydrogen atoms for a single atom of a metal. A similar abundance of hydrogen has been established in the case of most ordinary stars, as well as in the nebulae and in the exceedingly rarefied gas of interstellar space. Because of this prevalence of hydrogen in the Universe, it is of special interest to record those objects in which hydrogen is absent or, at any rate, of small abundance. Foremost among these objects is the remarkable variable star R Coronae Borealis. Its spectrum abounds in absorption lines of all the usual metals, but the lines of hydrogen are amazingly weak—so weak in fact that we must conclude that the abundance of hydrogen is one hundred or one thousand times less than it is in the sun. Another equally interesting star is Upsilon Sagittarii, an object which has been investigated in great detail by J. L. Greenstein at the Yerkes Observatory. Its spectrum resembles that of α Cygni, or Deneb. But in the latter the hydrogen lines are very strong, while in Upsilon Sagittarii they are exceedingly weak. Greenstein concluded that in this star hydrogen is only one hundred times as abundant as iron, and that helium is nearly one hundred times as abundant as hydrogen. In a list of the chemical elements arranged according to abundance the relative places of hydrogen and helium are therefore interchanged. It is tempting in this connection to think of the nuclear transmutations which take place in the interiors of the stars and thereby give rise to the light and heat radiated by them into space. According to H. A. Bethe of Cornell University, the predominant nuclear process in the stellar interiors consists of the gradual conversion of hydrogen into helium. This should slowly change not only the luminosity of a star but also its spectrum. However, before we can make safe deductions from our observations it is necessary to have an understanding of the process which leads to the formation of the stars and their gradual evolution. Might it not be possible that some stars were originally formed from a cloud of interstellar matter that was rich in hydrogen while other stars originated in a region of low hydrogen content? The interpretation of the observed abundances of the elements must therefore be supplemented by a careful study of possible regional effects. There is little theoretical information to lead us. We know, or we think we know, that atoms in interstellar space may collide and form molecules. These in turn may start to grow through the process of combining with other molecules so that we may gradually have a medium consisting of small particles, grains of matter too large to be called molecules. Through the work of L. Spitzer at Princeton and F. Whipple at Harvard, we believe that clouds of such particles will tend to form condensations which will gradually attract material from the surroundings and grow into stars. Such embyronic stars must be peculiar in their properties. They will be small in mass and luminosity and there is reason to believe that their spectra will be unusual.

A few years ago A. H. Joy at the Mount Wilson Observatory, announced the discovery of some 40 stars with unusual spectra located in and near the famous obscuring dust clouds in the constellation Taurus. More recently a star of the fifteenth apparent magnitude was found at the McDonald Observatory in Western Texas to possess an especially interesting spectrum. Its lines of hydrogen, helium and calcium are not in absorption, as they are in all normal stars, but appear as strong bright lines on top of a blue continuous spectrum. The star is seen projected upon the very center of an exceedingly dark and opaque cloud of cosmic dust. It is located on the nearer side of the dust cloud and produces something like a halo of diffuse light in the material of the dust cloud, just as a street light produces a

visible glow around it on a foggy night. Since the distance of the dust cloud is known, and since the star must be quite close to it, we know the distance of the star itself. We can therefore compute the intrinsic candlepower of the star. It turns out to be approximately 100,000 times fainter than a normal "full-grown" star of the same color. Hence, it must be very small in size. But we have as yet no knowledge of its mass and cannot compute the density of the matter within it.

It is possible that the star which we have described is a newly formed object produced as a condensation in the great dust cloud of Taurus. It is as yet much smaller and much less luminous than an ordinary star and it is probably only part way through the process of gathering up the dust around it. The impact of the particles of the cloud with the newly formed star could well explain the bright lines of hydrogen, helium, and calcium. As long as the star remains intrinsically faint, the surrounding grains of dust in the great cloud of Taurus will presumably continue falling into the newly-formed star, evaporating on the way and adding their mass and kinetic energy to the star. The latter will thus grow in mass and in size, and probably also in intrinsic luminosity. Gradually, the increasing candle power of the star will presumably tend to reduce the infall of the dust-particles through the action of radiation pressure. This pressure is always present when a beam of light falls on a particle, and it was measured in the laboratory, many years ago, by the Russian physicist Lebedeff. In the case of an ordinary star the light pressure exerted upon a very small particle is many times greater, in amount, than the force of gravity. Hence, all small particles are driven away from the stars, and are not falling into their surfaces. But an embryonic star, like the one in Taurus, has relatively little light, and the light pressure which it exerts must be quite small.

What happens in this case is the following. A particle of dust located on our side of the great cloud in Taurus will be subjected to the pressure of radiation from all the stars of the Milky Way, except those which are hidden by the obscuring cloud. The pressure will therefore by unsymmetrical, and the particle will be accelerated towards the cloud and the embryonic star associated with it. This motion will be resisted by the opposite pressure of the light of the embryonic star. Only when this star has grown in size will its own radiation pressure be sufficient to prevent the infall of dust particles. ●

A Way of Living

(Continued from Page 3)

ACCOMPLISHMENTS

I have been asked what we have accomplished in the five years of the Workshop, how we operate and what are our plans for the future.

What have we accomplished?

1. We have proven to our own satisfaction the correctness of our concept of a conservation workshop set up in 1943, our first year when we were pioneers with no precedent for guidance, (although we were to learn later of one that had been in operation in Ohio for a couple of years).

2. We take a bit of credit for other workshops which have been established during the past four years. We think our rushing in encouraged them to tread.

3. We believe our situation, apparently unique in the educational field of not being part of a department of an established educational institution but a result of the cooperative effort of a number of educational and civic groups, has made possible an approach in conservation teaching unhampered by academic practices, especially class room instruction and lectures, practices which would have destroyed our very purpose.

4. We have an efficient work pattern evolved by trial and error and in no small degree due to helpful suggestions of our students, for it must be remembered that our students are chiefly in-service teachers whose experience is valuable and solicited. We believe this work pattern to be highly efficient in that it gives individual instruction, affords first hand contact with various natural resources, provides uninhibited discussion, direct observation of conservation practices, opportunity to hear visiting authorities, question them, and discuss with them their realistic problems, and thus to become aware of what conservation problems there are throughout the nation and the world.

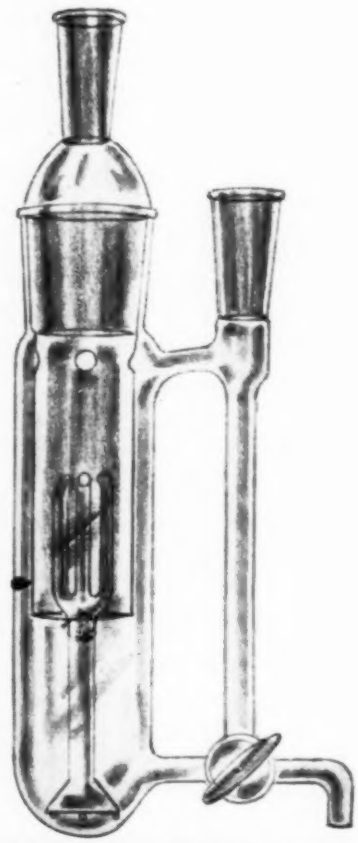
5. We have given teachers the realization that in conservation they have something real, vital, and far-reaching to give children. Writes one teacher: "It is really the Workshop that gave me all the background for the work I am now doing. I never could do it otherwise. My children are getting plenty of conservation". Said a school principal: "The Workshop gave me a philosophy of teaching I never got in all my years of training and experience". Said a superintendent of schools: "We promoted that teacher to a Junior High position because of what she learned at the Workshop." Said a Welfare worker: "My two weeks at the Workshop gave me an invaluable background for my new position as a Camp Fire Girl executive."

6. As a result of visits to the Workshop as a guest speaker for three consecutive years, the head of the biology department of an eastern college has revamped the whole biology course to bring emphasis on conservation of natural resources.

Improved VAPOR-LIQUID EQUILIBRIA APPARATUS

(Cottrell Choppin)

SIMPLE OPERATION
ACCURATE RESULTS
LOW COST . . .



This apparatus may be used either *for the study of vapor-liquid equlibria, or for determining molecular weights,* by the elevation of the boiling point of a solvent.

It consists of an ordinary Cottrell molecular weight apparatus modified by the addition of a three-way "T" type stopcock and a high precision thermometer graduated to 0.1° C. One arm of the three-way joint serves as a reflux return, another opens to the bottom of the flask and the third, serves as a sampling tube.

In this apparatus the advantages of the well-known Cottrell pump have been utilized in the determination of vapor-liquid equilibria.

Intensive experimentation with this apparatus has shown that it comes to equilibrium very quickly, yields highly accurate equilibrium data and is extremely simple to operate. Because of the simplicity of its operation, this apparatus is highly recommended for student use.

When the apparatus is used for determining molecular weights, the stopcock is set in the position which will allow the condensing vapor to return to the boiling flask, instead of escaping through the outlet tubes at the top. A Beckmann thermometer must be used for this type of application.

S-62000 MOLECULAR WEIGHT APPARATUS — Boiling Point, Cottrell Choppin, with modification for vapor-liquid equilibria, PYREX Glass. Without thermometer........ **$32.00**

S-80250 THERMOMETER — Chemical, Engraved Stem, Grinding No. 19/38. Range 50°-100° C., intervals of 0.1° C. Immersion, 6½". For vapor-liquid equilibria........ **$15.00**

S-81140 THERMOMETER—Beckman, Differential. Auxiliary Scale, Grinding No. 19/38. For molecular weight........ **$40.00**

SARGENT

SCIENTIFIC LABORATORY EQUIPMENT AND CHEMICALS

E. H. SARGENT & COMPANY, 155-165 EAST SUPERIOR ST. ·CHICAGO 11, ILL.

MICHIGAN DIVISION *1959 EAST JEFFERSON DETROIT MICHIGAN*

How do we operate? To meet expenses we have four sources of funds: tuition from students, state appropriation for maintenance and operation, appropriation from Rhode Island College of Education for instruction only, and a scholarship fund from the garden clubs of the State.

We regard the whole state as our laboratory and in the course of a two-weeks session we see a good part of it. The State has everything for study except mountains. It has many beautiful lakes, clear running streams, five large rivers. It is these rivers that make Rhode Island an industrial state since textile and other mills located along their banks must have water for power and processing. These rivers have their source in a mixed hard wood and coniferous forest which covers two-thirds of the state. Rhode Island has agricultural lands of fair fertility which yield good crops and considerable dairy products. It has 246 miles of shore line on Narragansett Bay and the ocean, making marine fisheries an important industry. It has swamps, marshes, hills, valleys, and valuable granite quarries. Its wildlife is mixed and of considerable commercial importance, including muskrat, fox, raccoon, and mink.

Each session is opened on a Sunday evening, the students having arrived, registered, selected their rooms and roommates, and begun acquaintance over supper out on the lawn. Then comes the first get-together. This is essentially for orientation. Introductions are made, the program explained, questions answered, directions given for the next day and note books distributed, for each student must have a note book the presentation of which becomes the basis for credit. We divide the whole group into four small groups and assign each of these to a different instructor, one in soil, one in water, one in plant life, and one in animal life. Each group meets its instructor at nine o'clock the next morning and spends the whole day in the field with him and his subject. Each day the groups change instructors so that in four days everyone has had a full day in each of the four subjects, in groups small enough to receive individual instruction.

We soft-pedal identification and memorizing names of such objects as trees, animals, and kinds of soil; not that these do not have a place, but their place is part of a larger whole as members of a biotic community. The one significant truth forced on the inquiring minds of the students during those first four days is the intimate relationships and the interdependence existing among natural resources:—no soil no life, no soil no forest, no forest no water, no food and cover no wildlife, no water no industry. By the fifth day students are ready to see how man manages or should manage these resources. On alternate days they go as one large group first to see actual management of soil by such methods as contour plowing, terracing, strip planting, drainage, ditching, and general land use.

Next comes an all-day trip in the forest under guidance of the State Forester. This includes study of the forest area controlling the water supply for the city of Providence, a stop at the fire dispatcher's station, a climb to the top of an observation fire tower, a survey of an area devastated by fire, and, finally, a visit to a hard wood forest where actual practice is had in determining the use to which different species of trees in different conditions of growth can be put.

A third day is spent at the State Lobster Hatchery and the Trout Hatchery, with a visit in the afternoon to a great swamp with its characteristic plant community. The day ends with a stop at the State's ocean bathing beach to note its use as a recreational area, and incidentally for a dip in the surf.

A fourth all-day trip is made down Narragansett Bay on an oyster boat to study marine fisheries and the effect of pollution of waters on those fisheries.

Our guest speakers are chosen as authorities in special fields. They are assigned to follow each all-day trip with an evening discussion. Incidentally, but most important, we do not allow them to make long technical talks. Rather, we ask them to present some specific topic for fifteen minutes and then open it for questions and discussion. Above all we want the students to be participants in every activity. Our workshop calls for and expects full participation by the students.

Alternating with the all-day trips are days at home to study pond life and stream life, insect life, resource materials, practice in methods of demonstrating conservation principles, and discussion of conservation problems and practices.

Every year, former students return to the Workshop. For them is offered during the second session an advanced course in the intensive study of a limited habitat area.

Does all this sound as if the students had no free time? Of course they have. Breakfast is at 7:35. Work begins at nine. Dinner is at 12:15. A rest period until two. Work to four. Then free time until 7:30, with a swim at a nearby beach for those who want to go. At nine o'clock we sing a song and are through for the day.

What of the future? Well, you are invited to join us this summer. There will be two sessions, June 20 to July 3, and July 4 to July 17. Tuition is $45 for a session of two weeks. Two semester hours credit are earned at Rhode Island College of Education which, upon request, will send a transcript of credit to an out-of-state college. ●

★ ★ ★ ★ ★

"To suspect the full measure of one's ignorance is the first step toward supplanting this ignorance with knowledge."

Robert Merton
Columbia University
Science
January 24, 1947

★ ★ ★ ★ ★

Little Red Schoolhouse

(Continued from Page 12)

ings which is without beginning and without end. He has become one of a great company of immortals. He has tapped the fountainhead of life itself.

There is a magic to radio that transcends the limitations of space and time. The wealth and treasures of the world are gathered into your classroom through its power. The great music of the world, the great literature. Great students, thinkers, scientists, leaders of the world. A man speaks in London, Paris, Rome. Before one-seventh of a second has elapsed we hear his words, even before the people in the auditorium with him. An event occurs in the Pacific. With but one-seventh of a second's lag we're hearing an eye-witness account of it, whether it be the dropping of an atom bomb or the playing of an international sports event. Sir James Jeans speaks of an expanding universe. Radio is the visible evidence of a shrinking world.

All this has changed our thinking, our mental and emotional reactions, and anything that changes our patterns of living must of necessity change our methods of education for life. So the little red schoolhouse has called in the electricians and wired up for this New Age which faces us so uncertainly that we must talk of it in platitudes arising from still unformed convictions.

Radio is faced with the tremendous responsibility of setting fact to fiction, of helping the individual listener, old or young, find his relationship to the swiftly moving events around him. All this is entering the schools. Let me show you a little of how it works.

As part of our *KDKA School of the Air,* we have a nature study program for the elementary grades. We wanted to express one underlying thought behind all the programs: that great marvels and wonders occur all around us constantly in the midst of the most prosaic surroundings, if our eyes are just trained to find them. To put across this idea without "preaching" it, we devised a nature sprite with the name "Intueris Ergo Vides". Ergo, for short, to those who know him. He translates his name whenever necessary for the children in the dramatic sketches; and through its power we go traveling down the roads, through the winding tunnels and into the busy chambers of the ant city. We travel through the watery tunnel to the beaver's home, shake ourselves in his dripping room, share with him his store of food and chat a while in his warm, dry sleeping quarters. We skim along the fly-ways with migrating birds. We visit in the chemical laboratories of the leaves where the work of photosynthesis is being conducted. We mingle with the thronging, bustling insect life along the trunk of a tree. We witness the intense dramas of life and death in the little world along our garden paths.

On Saturday evenings we have another science program, "Adventures in Research," for the high school group and the men and women who wonder sometimes at the changes science has made in our lives today. In that dramatic series we stand beside the man with the test tube. We experience his problems, his attempts to find a solution to them, his discouragements, his failures. With him we go without rest and sleep, we forget to eat. We suffer as he suffers. And eventually, with him, we share his victory.

This is the illustrious company the student keeps as he studies by radio. He marches in a vast army of heroic little people who have achieved through burning ideals, determination, unswerving conviction. The janitor, Leowenhoek, who looking through a lens of polished glass, told of "little beasties" he saw there. A tired French clerk, spending his extra hours watching the insects and the bees in his back yard. A shabby Polish woman crushing great heaps of black ore in a cold shed. It is little people who make the progress of civilization through the ages. The student can tell you about them. People working for the joy of accomplishment and with a sense of certain obligation to make some contribution to the well-being of the earth's inhabitants. Glorious little people.

But radio has moved beyond the fields of lower education. It has entered college, too. A group of medical students gather around a television screen. A delicate operation is being conducted by an eminent surgeon. The details are far clearer to the students where they are than to the assistants in the operating room itself. An instructor beside the screen explains the finer points of the operation. The science of life is moving on, more rapidly than it was possible before, because of radio.

All programs on the air are educational. For better or for worse, the student learns something from each thing he hears. And be assured his radio is turned on the greater portion of his waking hours. The teacher who relies only on the programs which she brings into her classroom is using radio to but small advantage. True, classroom programs are geared to classroom studies, but programs well-chosen from the rest of the broadcast day can be more valuable than textbooks written yesterday or the day before. We live in so immediate a world that today's knowledge may be obsolete tomorrow. A child cannot be fooled into accepting facts which are not applicable to the conditions in which he finds himself. He lives in the changing now. To hold him, to influence him, you must live there with him.

To use the abundance of broadcast material available, many schools are buying wire recorders or other recording equipment to transcribe nighttime broadcasts for use through the day. These are collected to form the basis of a transcription collection every bit as important to our modern red schoolhouse as its fine shelves of books in the school library. Many teachers assign outside listening as part of the homework. Children who have not listened find themselves left out of some of the most vital discussions of the classroom and will not let such an omission occur the second time.

Courses are given in listening in many of our colleges. Such courses should be, if they are not, closely tied in with courses in logic and thinking. But courses in listening should not be confined to college alone. The teacher wise in childhood's interests and ways of thinking can establish listening patterns which will set a child upon the road to relating all that he sees and hears and reads to his experiences of living. After all, education is a means of preparation for life. Why not use radio to intensify and enrich the process. ●

Aviation and Health

(Continued from Page 19)

disease depends largely on improved knowledge of where it exists, and exactly how it is transmitted.

One of the problems related to airplane transportation which has received a great deal of attention is the possible transportation of the vectors of disease, that is to say, not the individual who has been infected, but the insects or the rats which may inadvertently be transported by plane to a formerly uninfected area and thus cause a spread of the illness. An extensive study has been made of the types of mosquito found on planes which land at Miami.[7, 8] There was particular concern with the possibility of introducing the yellow fever mosquito into this country. It is true that *Aedes aegypti*, the chief "yellow fever mosquito", does exist in the United States, but these are not at present carriers of the yellow fever virus. As the map indicates, there are areas heavily infested with yellow fever in South America, and transporting *Aedes aegypti* by plane from such areas to this country would definitely introduce the danger of transporting the yellow fever virus also. As it turns out, however, we find that in the case of yellow fever the probabilities of transmitting the disease are very small. It has been stated that "*Aedes aegypti* do not ride on airplanes". [9, 10] Different species of mosquitoes have different habits, and although mosquitoes of many different types were found on planes, *Aedes aegypti* was never among them. For one thing, such a mosquito never flies very far, probably not more than a few hundred yards. The chances of its flying from a jungle spot into an airplane and then being transported seem to be very small. Further, if an *Aedes aegypti* should enter a plane and live to its destination, she might not be transporting the yellow fever virus. And on top of all this, a person receiving a virus from a mosquito still has a chance of not coming down with the disease. So we conclude that the probability of starting an epidemic in this way is indeed extremely small.

Between 1930 and 1940, Brazil suffered an unusually severe epidemic of malaria due to certain *Anopheles* mosquitoes which prior to that time had existed in Africa, but not in Brazil. [11] Aircraft were at first suspected of having imported the mosquito, but careful investigation shows that this was not the case. The *Anopheles* came over by ship from Africa. In another instance a tsetse fly, the vector of African sleeping sickness, was found on a plane in Brazil. The fly was dead; and as in yellow fever, the chain of circumstances required to produce an epidemic would be so long and so involved, that the chances of "success" are negligible. Nevertheless the possibility is always there, and we have no guarantee that this could not occur.

From the point of view of the spread of communicable disease, we should take the ordinary precautions in disinfecting airplanes, as is being done, even though that is not where the real danger lies. The danger lies in the transportation of individuals, and this has occurred often enough to indicate that the problem actually exists. There are a number of specific instances in which a person infected with malaria [12] flew from Africa to the United States and did not show symptoms until he had been in New York for some days. One of the unfortunate results was that since malaria in New York is uncommon, and since it is often difficult to diagnose, in several cases proper treatment was not given because malaria was not suspected and not recognized.

This points to the constructive rather than the negative role to be played by airplane transportation in the elimination of disease as a handicap to civilized man. We do not wish to push our neighbors away. We wish to have them closer to us. That is one of the reasons why air travel is desirable. Partly for this reason a system of health intelligence is being set up all over the world, managed under authority of the World Health Organization, an agency of the United Nations. In this way the existence of communicable disease in any local area will be reported to the central organization, and accumulated reports will be sent to any country desiring the information. Thus when passengers from Dakar arrive in Sydney, the health officer in Sydney knows what precautions are necessary.

The difficulties inherent in such a system have been recognized, and it has been suggested that the world's airlines could justifiably bear some of the cost. [13] Perhaps that is true. However, the matter of quarantining and preventing the spread of communicable diseases should be considered as a temporary expediency, and not as the answer in improving the public health of the world. The speed of air travel and the increased facility of communicating with our neighbors not only makes it desirable, but makes it possible for those of us who happen to have developed effective means of eliminating disease to transmit this knowledge to those parts of the world which have not been so fortunate. Within the United States for example, as within most other civilized countries, disastrous epidemics are not likely to occur because local means of control are fairly well developed and effective sanitation is generally practiced. It would seem much more appropriate to suggest that airlines contribute to undertakings such as those already conducted by the Rockefeller Foundation and other philanthropic institutions, namely the education of the less civilized portions of the world in the principles of sanitation and prevention of disease. We can expect that by means of closer ties, easier communication and travel, and resulting improvement in

economic conditions, a city like Shanghai or Calcutta can be raised to a level of sanitation comparable to London or New York, for example. Our aim should be to make the world a place where persons can come and go without passing through barriers separating the sanitary from the unsanitary, the healthy from the sick. We shall thus not only be taking the best possible steps towards the elimination of many of our communicable diseases, but we shall be demonstrating the value of air transportation in advancing the civilization of the world.

As stated in the preamble to the Constitution of the World Health Organization: "Unequal development in different countries in the promotion of health and control of disease, especially communicable disease, is a common danger." [14] The role of aviation applies to an even broader view. According to this same constitution: "Health is not merely the absence of disease, ... it is a state of complete physical, mental and social well-being." [15] ●

REFERENCES

1. Amer. Public Health Assoc.: "The Control of Communicable Diseases", 1945, 6th edition.
2. *Health News*, New York State Department of Health, April 28, 1947.
3. *Quarterly Bulletin*, Department of Health, New York City, April 1947.
4. "Sanitary Aerial Navigation, Convention between the United States of America and other Powers", Treaty Series, No. 901, U. S. Govt. Printing Office, 1935.
5. "International Sanitary Convention for Aerial Navigation, 1944", H. M. Stationery Office, London, 1945.
6. J. S. Simmons, T. F. Whayne, G. W. Anderson, H. MacL. Horack: "Global Epidemiology", J. B. Lippincott Co., 1944.
7. *Public Health Reports*, April 2, 1937, "Mosquitoes on Airplanes".
8. E. V. Welch: "Insects Found on Aircraft at Miami, Fla. in 1938", *Public Health Reports*, April 7, 1939.
9. T. B. Magath: "Quarantine Procedures with Special Reference to Air Travel", *Jour. of Aviation Medicine*, June 1945.
10. T. B. Magath and P. T. Knies: "Modern Concepts of International Quarantine with Special Reference to Military Traffic", *The Military Surgeon*, March 1945.
11. T. L. Soper and D. B. Wilson: "*Anopheles gambiae* in Brazil, 1930 to 1940", Rockefeller Foundation, 1943.
12. H. Most and H. E. Meleney: "Falciparum Malaria", *Jour. Amer. Med. Assoc.*, Jan. 8, 1944.
13. Times News Bureau, communication re: Dr. J. C. Geiger, Director of Public Health, San Francisco, Dr. Gilbert Dunnahoo, Chief of Foreign Quarantine Division, U.S.P.H.S., "Globe-Encircling Health Stations".
14. *Public Health Reports*, August 30, 1946, "Constitution of the World Health Organization" (reprint No. 2752).
15. T. Parran and F. G. Boudreau: "The World Health Organization: Cornerstone of Peace", *Amer. Journal of Public Health*, November, 1946.

★ ★ ★ ★ ★

"Of course the real key to the cultivation of science talent is the teacher himself—and he needs time to be a real person. It is doubtful if he can assist someone else to develop if he is not himself progressing. We see too many teachers who 'ride' on what they learned in college. We see almost no one in the secondary schools who has a project of his own."

Madeleine Frink Coutant
Time for Science Instruction, 1946

★ ★ ★ ★ ★

Botanical Exploration

(Continued from Page 16)

former trained at the Gray Herbarium, the last two at the Arnold Arboretum. In the meantime K. K. Tsoong, a classical student of the old school, had received botanical instruction in Japan, and became the first professor of botany in China at Peking University. He prosecuted botanical field work in various parts of eastern China, extending his operations to Hainan and later to Yunnan, but he never published very much. In 1923 I dedicated the genus *Tsoongia* to him, based in part on Kwangtung material he sent to me for study. Since that time many Chinese graduate students have specialized in botany in this and in various American institutions, and in Berlin, Paris, Edinburgh, London, and other centers.

My personal attitude from the time of my first contacts with the young Chinese botanists was that they should take the lead not only in field work, but also in actually studying their own collections and in publishing the results. I promised them all the assistance that I could render, which at first was merely submitting lists of approximate identifications on the basis of duplicate sets submitted for identification, suggesting those species which they might study intensively with profit to themselves. A considerable number of joint papers were prepared and published, particularly in cooperation with W. Y. Chun.

In Manila I had so far broken down the intricacies of governmental accounting that I had been able to advance modest sums to support botanical field work in Borneo and in Guam, the grants going to institutions and individuals. The results were extraordinary as compared with what might have been received on the basis of a financed trip by some staff member, that is, salary and traveling expenses. True, some of the notes were rather sketchy, but nevertheless useful. In a large collection made for me under the auspices of the Sarawak Museum at Kuching, Borneo, apparently the native collector employed had been a sailor, for his notes, in English, were not only a bit sketchy, but sometimes intriguing, such as "taken from a tree 5 fathoms from the ground;" he at least had the idea, even if his limited English was a bit nautical. From Manila as a center my operations were extended to eastern China, but aside from three trips that I made on vacation time, the operations took the form of encouragement to local residents.

It should be realized that if one desired to secure natural history material from China before 1915, the only feasible way was to finance an expedition, involving salaried time and heavy travel expenses, and most

botanical institutions have limited incomes. I could cite expeditions that cost many thousands of dollars, and yet certain recent extensive field operations on a co-operative basis brought in as much or more material as did these very expensive expeditions for an actual grant of only $500.00. There were few European residents in China equipped to prosecute field work, and no trained Chinese botanists. As the young, energetic, well-trained Chinese botanists returned to China and established their research centers, the conditions changed.

At the University of California, 1923-1929, it was possible for me to make certain modest grants on the basis of gift funds provided for the purpose. At that time I was interested in building up the Chinese collections in the University herbarium. When I transferred to the New York Botanical Garden in 1930, I was able to increase these grants slightly, but was still handicapped by the limits on institutional income and the difficulties of the depression years. Finally, after becoming affiliated with the Arnold Arboretum of Harvard University in 1935, with more ample extra-budgetary funds available, it was possible for me to amplify this special field of action. Individual grants were never large, varying in amounts from a minimum of $50.00 to a maximum of $500.00. These funds were provided to cover the expenses of field work, for, generally speaking, the collectors involved were salaried staff members of this or that Chinese institution. The cooperative field work was predicated on an equitable division of the material collected between the cooperating institutions; normally, if an average of eight duplicate specimens was prepared in the field representing a single species, four of them were retained and four were sent to the Arnold Arboretum, in other words, a sort of 50-50 arrangement.

Over a period of twelve years, interrupted of course by the war, but renewed after the cessation of hostilities in China, grant after grant was made, sometimes for special objectives, sometimes left to the discretion of the recipient as to how and where the funds should be used. Institutions involved included the Fan Memorial Institute of Biology, Peiping; National Southeastern University and Nanking University, Nanking; Lingnan University and Sunyatsen University, Canton; Yunnan Botanical Institute, Kunming, and others. The areas explored included most of the provinces of China, from Manchuria in the north to Kwangtung (including Hainan) and Kwangsi in the south, even including northern Indo-China, west to Szechuan, Yunnan, and Tibet. The results have been spectacular, and of great benefit not only to the institution that was fortunately able to supply the funds, but even of greater importance, to the recipient institutions. In China it enabled the directive staff members to initiate most important field operations on a large scale in areas often very imperfectly known, and to assemble the basic material needed on which their staff members could prepare important contributions to our knowledge of the Chinese flora.

Within the present century our knowledge of the Chinese flora has been vastly increased. I mention the fact that somewhat more than 500 new species of *Rhododendron* have been described from China alone since the year 1900. Other extraordinarily large genera are *Quercus*, *Primula*, *Gentiana*, and *Pedicularis*, to mention only a few. When the Japanese invaded China, thus initiating what later developed into the second World War, we actually had in storage in various parts of western China approximately 25,000 numbers of botanical specimens, and now an attempt is being made to get this material shipped. At the time of the Marco Polo bridge incident, in the summer of 1937, the great collection of botanical material from Szechuan and Yunnan that had been assembled over a period of several years was in Peiping, but sorting had not been completed. Later in the year our share, representing perhaps 35,000 specimens, was shipped through the co-operation of the American consular officials, as ordinary routes of transmission had been closed, or were at least unsafe. After the Japanese occupation of Indo-China, one of our cooperating collectors being then in the field south of the Kwantung-Kwangsi border, succeeded in getting his entire collections back to Hongkong and shipped in the nick of time. Occasionally there has been a loss, but not often. When the fighting developed in Kwangtung Province one of our collectors was in Kwangsi Province. On the trip down the Sikiang River the boat on which he was a passenger was bombed by the Japanese; he lost the entire collection and nearly lost his life in an attempt to reach the shore; and yet on his arrival in Canton he sent word that he was willing to make the trip a second time at his own expense to replace what had been lost. He was naturally not required to do so!

Incidentally, in an attempt to strengthen the reference collections of the Arnold Arboretum in other areas similar grants were made from time to time to institutions and individuals in Burma, Siam, the Malay Peninsula, British India, Sumatra, Java, the Philippines, Australia, and even tropical Africa. And modest grants were made to help finance the three spectacular Richard Archbold Expeditions to New Guinea, and now to the Cape York Peninsula, on the basis that the resulting botanical collections be placed at the disposal of the Arnold Arboretum.

The Arnold Arboretum is now 75 years old, having been established in 1872. Its operations in the eastern Asiatic field commenced at an early date, but at first chiefly with a view to introducing hardy woody plants that might be adaptable to the climatic conditions of New England. Within the present century, however, it has financed important trips such as the exceedingly profitable ones of E. H. Wilson, J. F. Rock, and others, in China, partly for the purpose of introducing living plants and for collecting seeds. But the base was fortunately amplified to cover also comprehensive collections of herbarium material for study purposes. It was fully realized at an early date that the one great potential source of new ornamental plants adapted to our climatic

conditions was China, and today a surprisingly high percentage of the approximately 6500 species and varieties of woody plants now being successfully grown in the Arnold Arboretum came from China; again, a surprisingly high percentage of the woody plants grown for ornamental purposes not only in the United States, but in Great Britain and in Europe as well, stem from these original Arnold Arboretum introductions. I merely mention in passing that under the climatic conditions of Boston it has been found to be impossible to grow out of doors any woody species of the South Temperate Zone, and that our living stock has been derived entirely from parts of North America, Europe, and Asia.

Thus it is in building up our present knowledge of the Chinese flora that there has been close cooperation between a great many individuals, those working in the field, and those working in various botanical institutions in Leningrad, London, Berlin, Edinburgh, Paris, Geneva, Utrecht and a few other centers in Europe; and in the United States, Cambridge, through Asa Gray's work on the botanical collections assembled by the American Expeditions to Japan and China, and the Wilkes Expedition which circumnavigated the globe, later through the efforts of the Arnold Arboretum, the Smithsonian Institution, the University of California, and the New York Botanical Garden. The disinterested aims have been to make known the rich flora of China, which in the number of genera and species is not matched in any comparable area in the temperate parts of the world. Much has been due to the series of cooperative exploration projects where even a modest grant to a young institution has meant much more to the recipient than can be measured in dollars and cents. These grants provided the needed margin over and above budgetary provisions that enabled their directors to accomplish a vast amount of important work which otherwise would have remained undone.

China is known as the mother of gardens. A surprisingly high percentage of our cultivated ornamental plants originated in that country. It has been stated, in reference to the exploration of China, that perhaps we are approaching the point of diminishing returns as far as we may expect spectacular additions to our store of cultivated species from this source. However, I cite one instance. During the war one of the Chinese botanists on a trip to a remote valley in Szechuan, discovered a stand of three trees only, somewhat over 100 feet high, perhaps allied to the American *Sequoia*, but deciduous rather than evergreen, as are the larches and the golden larches. Study of this material showed, indeed, that it represented the genus *Metasequoia* which had been described a few years earlier from fossil specimens. In 1946 another grove of about 25 trees was located in the same general neighborhood. Immediately intrigued with the possibilities I at once offered a modest grant, sufficient to cover the expenses of a field trip, the objective being to secure viable seeds so that we could introduce this tree into cultivation in the United States. The offer was accepted, the fund transmitted to Peiping, and as I was writing this note I received word that the expedition had been successful, that although it was not a good seed year, a quantity of seed had been secured, to be forwarded at once, and what is more, that a third stand of this tree had been located by Mr. Hsueh on the Arnold Arboretum financed expedition.

Metasequoia was a genus of wide geographic distribution in former geologic times in the North Temperate Zone; and now, in the year of our Lord, 1947, we receive seeds from the small groves in remote Szechuan apparently representing the last stand of a genus on the verge of extinction. This, in botany, is almost as spectacular as if some modern herpetologist should discover a living specimen of one of the giant extinct groups of reptiles, a group that dominated the fauna of the world in the age of reptiles. This was during the Mesozoic era, and it was in the Triassic and Cretaceous periods of that era that the primitive flowering plants, the Gymnosperms, of which *Metasequoia* is a representative, dominated the vegetation of the earth. The great reptiles have long since become extinct, but certain of the vegetable types characteristic of those ancient times still persist. ●

★ ★ ★ ★ ★

The primary end of science is the gaining of knowledge of the physical world. But this knowledge cannot be won by standing aloof and passively observing the world. The scientist must experiment; he must actively interfere with the course of things.

Philip Morrison
Cornell University
Journal of General Education
Vol. 1 No. 3 April 1947 p. 211

★ ★ ★ ★ ★

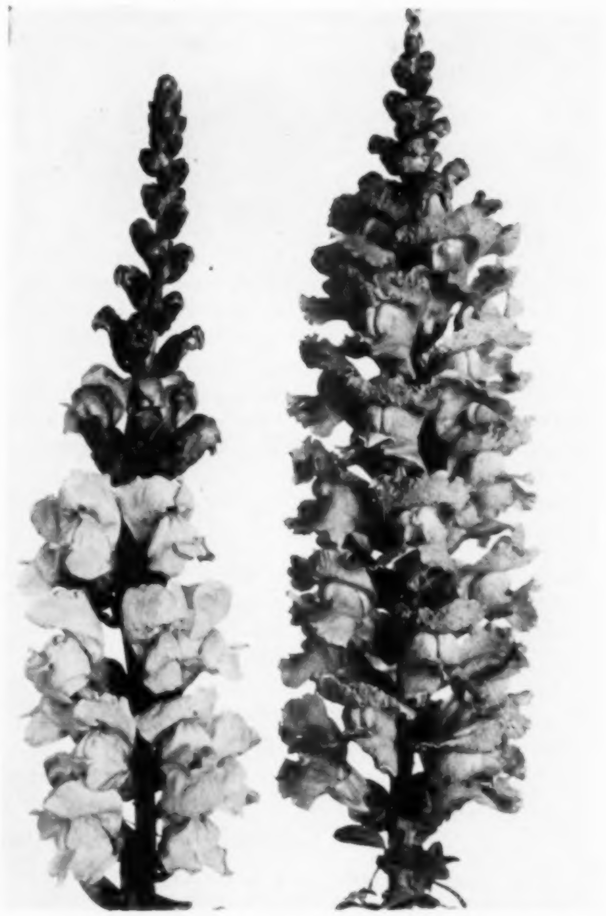
How Seeds Are Grown

(Continued from Page 14)

W. Atlee Burpee used to travel upward of 30,000 miles every summer visiting trial grounds and private gardens in his search for good plants, ready-made by nature. His plant hunting paid dividends. The senior Burpee introduced such long famous varieties as Spencer sweet peas, Bush lima beans, Rocky Ford muskmelons, Danish Ballhead cabbage, Iceberg lettuce, Golden Self-Blanching celery, Red Ball beets, Golden Bantam sweet corn, and many others.

David Burpee, too, started out as a plant hunter but soon became impatient. "Hunting for miracles," he said, "is too slow. It will be better if we can make our own." So instead of hunting new varieties of flowers and vegetables he took a page from the book of Luther Burbank and started building them to order, catering to the latest whim of the housewife, shipper, or canner.

His method is cross-breeding and hybridization—combining the desirable characteristics of several plants



COMPARISON OF REGULAR DIPLOID VARIETY with new tetraploid Snapdragon—the result of treatment with Colchicine.

into one variety. He and his plant scientists crossbreed hundreds of flowers and vegetables to make them bigger and better, prettier, more hardy, earlier, better tasting, or whatever they think will improve the strain. Some modern varieties are so improved they wouldn't recognize their own grandparents.

Some of Burpee's greatest successes have been in the field of F_1 (first generation) hybrids. Hybrid corn, of course, has been on the market for a number of years, producing bigger crops which mean more food for consumers and bigger profits for market growers. Producing the seed for hybrid corn, however, is comparatively simple because you let the wind do the work of cross-pollination. But with such vegetables as tomatoes and cucumbers this tedious work must be performed by hand and repeated every year. For this reason it has always been considered too costly to be practical.

In 1944, David Burpee decided to try it anyway. He hired 60 girls from Smith, Vassar, Bryn Mawr and other colleges to spend the summer hand-pollinating tomato blossoms on his Fordhook Farms. The resultant seed produced an extremely heavy yield of large, deep-red, rich-flavored fruits, comparatively high priced but tremendously popular among both market growers and home gardeners. Fordhook hybrid tomatoes, along with Burpee hybrid cucumbers, were offered to the public for the first time in 1945. Since then three more hybrid tomatoes and a new hybrid egg plant have been added. All have become "best sellers". The hybrid, says Mr. Burpee, is here to stay.

Recent scientific tests show he is right about hybrid superiority. In many localities under widely varying conditions the hybrids have led all standard varieties in size, quality, and yield per acre.

Another development in the seed world is even newer than hybridization, and a great deal more spectacular. In 1940, David Burpee put into practical commercial use the scientific experiments of a Carnegie Institute geneticist, Dr. Albert Francis Blakeslee. Dr. Blakeslee was using the drug colchicine, derived from the root of the autumn crocus, to double the chromosomes in the germ cells of plants and produce sharp changes which bred true. In some varieties this "shock treatment" changed the plants so much they were barely recognizable. In other plants, however, the primary characteristics were retained, but the rate of growth increased. Color became intensified, and flowers grew larger, bloomed longer and were generally improved.

The first colchicine-produced variety was a tetraploid (double-double) marigold. Two years later Mr. Burpee achieved somewhat similar effects by the use of x-ray. He introduced two new calendulas which he called his X-ray Twins. In 1946, the colchicine-produced tetraploid snapdragon became a popular favorite and has been dôing well ever since.

An indication of a far-sighted and progressive attitude toward scientific improvement in the seed industry is the establishment of an annual Burpee Award in Horticulture at every agricultural college in the United States, Alaska, Hawaii and Puerto Rico, at least one in each of the 48 states. In addition to this, Burpee scholarships and fellowships for students of genetics have been long established in several eastern and midwestern colleges. Since 1941, a number of especially promising horticulture students from South and Central America have been sent to the University of Florida and educated under the Burpee Scholarship in Horticulture for Latin America.

This, then, is the story of Burpee's, and in a way, the story of other American seed growers. As David Burpee says, seed is basic and a flower or vegetable is only as good as the seed it grows from. And that is why seed growers everywhere are constantly striving to improve the quality of their products—to put more food, better food, and lovelier flowers in the homes and gardens of America and the world—and to put them there as rapidly as possible. ●

Friends of the Land

(Continued from Page 2)

to be set up. Since then chapters have been set up in almost every state in the Union. Some states have several chapters. Some are in rural areas, some are in cities, some in small towns, some state-wide in scope. Some states, like Ohio, have several chapters. Among the cities are Philadelphia, Cleveland, Chicago, Columbus, St. Louis, Milwaukee and many others. Each chapter has great freedom of operation and is only loosely affiliated with the head organization. Some present large two-day forums each year with a distinguished list of speakers, some hold biennial meetings, some monthly dinner meetings. New chapters are being constantly formed.

Not the least of the educational benefits achieved by the organization have been the articles on the subject of conservation and better agriculture and forestry practices, which have appeared in the national press and magazines in increasing numbers. Many of these were written and placed through the efforts of the society and most of them have been written by members. The list of publications includes the most important in the nation—*Reader's Digest, The Saturday Evening Post, Collier's, Life, Fortune*, and countless others.

The society has functioned always upon a basis of economy and often of voluntary services. It has maintained a small staff in the central office which has been increased only as the growing membership and responsibilities forced the growth. Twice a year, the society holds a national meeting in some American city where a two-day forum and a one-day business session are held.

The purpose of the society has been to enlist the interest and *activity* of intelligent leading citizens, and it has always urged not merely the payment of a small sum for membership but actual participation in the activities, local, state, and national, of the organization. It has set up several categories of memberships, ranging from $2500 yearly for a corporation participation to five dollars a membership for the average citizen. Special memberships for teachers, pastors and librarians have been set up at three dollars. All memberships include a subscription to *The Land* and *The Land Letter*.

It is safe, I think, to say that no organization or group of men and women has done so much to awaken the nation to the vital importance of its natural resources and real wealth as the Friends of the Land. There is testimony of the growing regard for the gravity of the problem in the recent comprehensive surveys made by the Department of the Interior and the New York Herald Tribune of the status of our natural real wealth and how much of it remains. Confronted with a bankrupt and starving world, the United States cannot possibly undertake the rehabilitation of all or even most of that world. Most economic and political thinkers of our times recognize our agricultural land, our forests, our mines and oil wells, as the real basis of our economic and political power as a nation, and concede that when these are dissipated or used up, we shall become a tenth-rate nation.

Most of those concerned in the founding and growth of the Friends of the Land have been and still are men and women of importance and responsibility and above all, extremely busy people. The list is a long one, including five Federal Reserve Bank presidents, including Chester C. Davis, Past President of The Friends, Josiah Bowman, President of Johns Hopkins University, Jonathan Forman, Paul Sears, author of "Deserts on the March" and head of the Department of Botany at Oberlin College, E. J. Condon, Executive Assistant to the President of Sears, Roebuck and Company, Dr. Charles Holzer, internationally known surgeon, Murray Lincoln, Secretary of the Ohio State Farm Bureau, Wheeler McMillen, editor of the "Farm Journal," J. N. Darling, the famous cartoonist, and dozens of others of similar caliber.

The society has still to celebrate its tenth anniversary. Its steady growth represents one of the finest manifestations of the spirit of public responsibility, which is the backbone of democracy. The national headquarters are at 1368 North High Street, Columbus, Ohio, from which further information can be obtained. ●

★ ★ ★ ★ ★

The great teacher has a lively and irrepressible intellectual curiosity and freedom from personal preoccupation. He has the ability to analyze and synthesize the facts involved in any problem; and to arrive at solutions objectively, and without prejudice. He has cultivated good habits of study; and knows how to organize and how to impart knowledge. He realizes, however, that the objective of education is not to drill knowledge into people, but to strengthen their mental capacities; and that good teaching does not result in individuals crammed with mere facts, opinions or phrases of other people; but people who have ability to think and to form their own opinions. He encourages his students to use their own minds, and to avoid following furrows traced for them by others."

A. A. Potter
Dean of Engineering, Purdue University
Association of American Colleges *Bulletin*
December, 1947

★ ★ ★ ★ ★

"Faith gives the courage to live and do. Scientists, with their disciplined thinking, like others, need a basis for the good life, for aspiration, for courage to do great deeds. They need a faith to live by.

The hope of the world lies in those who have such faith and who use the methods of science to make their visions become real. Visions and hope and faith are not part of science. They are beyond the nature that science knows. Of such is the religion that gives meaning to life."

Arthur H. Compton
The American Digest, Nov. 1946